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Projecting The Demand For Ohio River Basin Waterway Traffic Using Correlation And Regression

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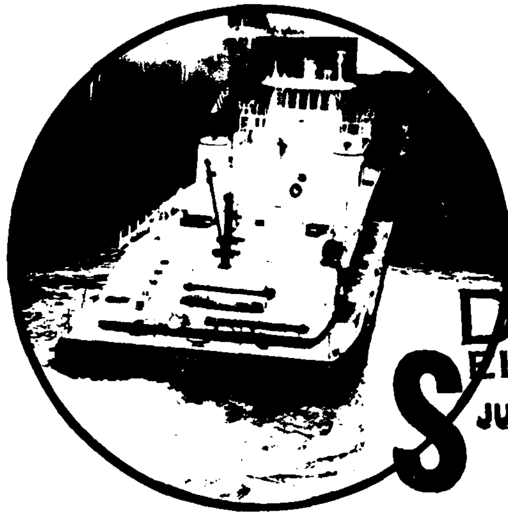

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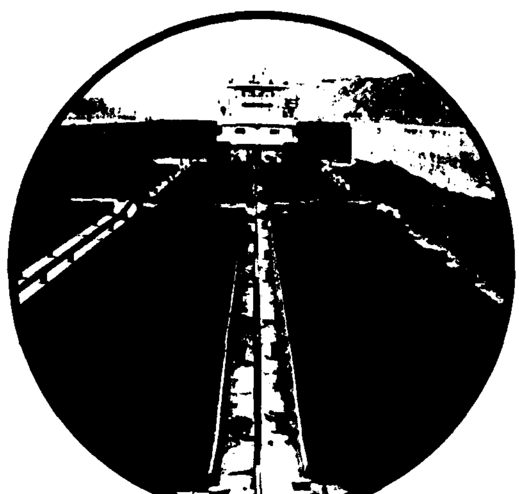

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This ~~Corps of Engineers~~ report describes one of three independent but complementary studies of future freight traffic on the Ohio River Basin Navigation System. Each of the studies considers existing waterborne commerce and develops a consistent set of projections of future traffic demands of all of the navigable waterways of the basin. Each report contains information on past and present waterborne commerce in the basin and projections by commodity group and origin-destination areas from 1975 to at least 1990.

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The three study projections, in conjunction with other analytical tools and system information, will be used to evaluate specific waterway improvements to meet short and long-term navigation needs. The output from these studies will serve as input to Corps' Inland Navigation Simulation Models to help analyze the performance and opportunities for improvement of the Ohio River Basin Navigation System. These data will be used in current studies relating to improvement of Gallipolis Locks, the Monongahela River, the Upper Ohio River, the Kanawha River, the Lower Ohio River, the Cumberland River and the Tennessee River, as well as other improvements.

This report and the 1975-1990 projected traffic demands discussed in it were developed by correlating the historic waterborne commodity flows on the Ohio River Navigation System with various indicators of regional and national demands for the commodities. The demand variable(s) which appeared to best describe the historic traffic pattern for each of the commodity groups was selected for projection purposes. The historic and projected values for the demand variables are based upon the 1972 OBERS Series E Projections of National and Regional Economic Activity. The OBERS projections were developed by the Bureau of Economic Analysis of the U.S. Department of Commerce in conjunction with the Economic Research Service of the Department of Agriculture.

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PREFACE

This Corps of Engineers report describes one of three independent but complementary studies of future freight traffic on the Ohio River Basin Navigation System. Each of the studies considers existing waterborne commerce and develops a consistent set of projections of future traffic demands for all of the navigable waterways of the basin. Each report contains information on past and present waterborne commerce in the basin and projections by commodity group and origin-destination areas from 1975 to at least 1990.

The three projections, in conjunction with other analytical tools and system information, will be used to evaluate specific waterway improvements to meet short- and long-term navigation needs. The output from these studies will serve as input to Corps' Inland Navigation Simulation Models to help analyze the performance and opportunities for improvement of the Ohio River Basin Navigation System. These data will be used in current studies relating to improvement of Gallipolis Locks, the Monongahela River, the upper Ohio River, the Kanawha River, the lower Ohio River, the Cumberland River, and the Tennessee River, as well as other improvements.

This report, completed in January 1979, was prepared for the Corps by CONSAD Research Corporation of Pittsburgh, Pennsylvania. The study and the 1975-1990 projected traffic demands discussed in this report were developed by correlating the historic waterborne commodity flows on the Ohio River Navigation System with various indicators of regional and national demands for the commodities. The demand variable(s) which appeared to best describe the historic traffic pattern for each of the commodity groups was selected for projection purposes. The historic and projected values for the demand variables are based upon the 1972 OBERS Series E Projections of National and Regional Economic Activity. The OBERS projections were developed by the Bureau of Economic Analysis of the U. S. Department of Commerce in conjunction with the Economic Research Service of the Department of Agriculture.

A second report, completed in February 1979, was prepared for the Corps by Battelle Memorial Institute, Columbus, Ohio. The study and the 1975-1990 projections discussed in that report were developed by surveying all waterway users in the Ohio River Basin through a combined mail survey and

personal interview approach. Personal interviews were held with the major existing waterway shippers. The purpose of the shipper survey was to obtain an estimate from each individual shipper of his future commodity movements by specified origins and destinations, as well as other associated traffic information. The responses were then aggregated to yield projected traffic demands for the Ohio River Navigation System.

A third report, to be completed in September 1979 is being prepared for the Corps by Robert R. Nathan Associates, Inc. of Washington, D. C. The study and the 1975-2040 projections to be discussed in that report are much more comprehensive in scope, and focus on a much longer time frame. The basic study approach involves placing the historic production, consumption, and net shipments (by transportation mode) of commodities which move by water in the Ohio River basin into perspective with total national output. The production, consumption, and shipment estimates are being prepared for all geographic areas within the basin which are either directly or indirectly (through modal transfers) served by the Ohio River Navigation System. Economic, environmental and institutional factors which have historically affected output, consumption and modal shipments are being identified and analyzed. These same variables will then be projected through the year 2040 under alternative scenarios. Detailed waterway flow projections by commodity group and origin-destination areas will then be presented for the most probable future condition.

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1.0 INTRODUCTION AND PURPOSE

In 1976 nearly 180 million tons of commerce was carried on the waters of the Ohio River navigation system. Most of this consisted of bulk-type commodities such as coal, sand, gravel, crushed rock, and petroleum fuels. These materials constitute major inputs to the basic industrial and energy production processes of the United States.

In order to insure the continued smooth flow of the above commodities, the U.S. Army Corps of Engineers must continue to maintain and improve the conditions of the rivers and navigation projects in the Ohio River Basin (ORB). Since funds for this purpose are limited, the Corps must develop a strategy for application of their financial resources so as to best achieve this goal.

As part of a systemwide study of commercial navigation in the ORB, the Huntington District of the U.S. Army Corps of Engineers has retained the services of CONSAD Research Corporation to project the demand for future ORB waterway traffic for the period 1975-1990.* The primary study area is defined to be the main stem Ohio River and all of its commercially navigable tributaries, including the Monongahela, Allegheny, Kanawha, Kentucky, Green, Cumberland and Tennessee Rivers. The elements of this analysis have consisted of the following:

TASK 1: Estimate future waterway traffic by commodity group (see Table 1 and Appendix E) for the Ohio River Navigation System for the period 1975-1990 using correlation and regression techniques. The historic waterway traffic data to be used for this task shall be collected from <u>Waterborne Commerce of the United States</u>, Part 2.

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*This is only one of three ORB projection studies being undertaken by the Corps. The second study is based upon surveys of shippers and receivers while the third study is examining a number of basic market conditions and trends.

Table 1: COMMODITY GROUPINGS TO BE UTILIZED FOR PROJECTING OHIO RIVER BASIN WATERWAY TRAFFIC

	COMMODITY GROUP
1.	Coal and Coke
2.	Petroleum Fuels
3.	Crude Petroleum
4.	Aggregates
5.	Grains
6.	Chemical and Chemical Fertilizers
7.	Ores and Minerals
8.	Iron Ore and Iron and Steel
9.	All Other

TASK 2: Using 1969-1975 PE-PE* and BEA-BEA** flow data to be provided by the Corps of Engineers, the forecasts from Task 1 shall be allocated to the BEA economic areas and river reaches within and outside of the Ohio River Basin, by commodity group. These future movements will then be aggregated by direction to the main stem Ohio River, each navigable tributary, and through each of the seventy-one navigation projects in the Ohio River navigation system.

TASK 3: Separate, independent projections of waterway traffic by commodity group and direction of movement (upbound-downbound) will be generated for the main stem Ohio and each navigable tributary in an attempt to identify the degree of association between the behavior of the total Ohio River navigation system and its components. A similar analysis is also to be performed for traffic passing key navigation projects in the Ohio River System (see Section 2.3.3 for details). These subsystem studies are intended to test the reliability of basinwide projections throughout the system.

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*PE stands for "port equivalent" and refers to a stretch of river possessing a composite of port characteristics. The term was defined as part of the Inland Navigation Systems Analysis program of the Corps of Engineers as an aid in water simulation projects.

**The term BEA as used in this report will refer to any of the 173 economic areas into which the Bureau of Economic Analysis has divided the United States.

2.0 ANALYSIS

This section describes the data, its inspection and coding, and the analytic techniques employed in projecting the demand for future ORB traffic.

2.1 Data: Collection, Coding and Manipulation Procedures

The data on the movements of commodities on the rivers under investigation were collected from Waterborne Commerce of the United States, Part 2, for the years 1953-1975. Prior to 1953, (back through 1940) this same information appeared in the Annual Report of the Chief of Engineers, Part 2, "Commercial Statistics". The former data was provided by the project sponsor, while the latter set was procured from the University of Pittsburgh library, and the libraries of the Pittsburgh and Washington, D. C., offices of the Corps of Engineers.

The data was coded much in the same way as it appeared in the later volumes of Waterborne Commerce. That is, for each commodity, the directional distinctions of up river, down river, in river, out river, and through river (up and down) were retained to provide the maximum amount of flexibility in the data file. In addition, river and year codes were also included.

Numerous inconsistencies were found in this 36-year data set. The most glaring were the many changes encountered in the commodity code classifications. Prior to 1965, when a standard 4-digit commodity classification code for shipping statistics was adopted, three different 3-digit coding schemes were encountered; one version for the years 1949-1964, another for 1948, and a third for the years 1943-1947. In addition, the data for years 1940-1942 had no codes associated with the commodity listings.

This problem was remedied by entering the 3-digit codes as they appeared into the computerized data file, and then for each 3-digit coding scheme, a computer program was written and applied to convert these codes into the standard 4-digit scheme, (see Appendix A). In the case

of the data for years 1940-1942, where no codes were utilized, the most appropriate standard 4-digit code was applied and entered into the data file.

Another inconsistency encountered was the extremely detailed breakdown of commodity tonnages in the older data compared to what was adopted in the standard 4-digit scheme. As an example, in 1940 on the Ohio River, in the "Outbound Ores, Metals, and Manufactures of" category, such commodities as grave vaults, range boilers, and signs were listed. However, in consulting the standard 4-digit code, these commodities and several others listed in that same category were all subsumed in the "Fabricated Metal Products Except Ordinance, Machinery, and Transportation Equipment" category. In general, every effort was made to locate the most appropriate standard 4-digit classification.

The Cumberland River presented a unique problem. Several years of commodity tonnage data was organized only by "Below and Including Nashville" and "Above and Excluding Nashville" categories. No separate "whole river by direction" chart existed. Special care had to be taken in converting this data breakdown to the one we were employing for all the rivers. The "net total" listing (directionless) was used as a guide in this conversion task.

The Ohio River also presented a unique situation. A separate "oceangoing" chart was often presented in addition to the domestic data. This chart included imports and exports as well as the "domestic coastwise" category which refers to domestic traffic receiving a carriage over the ocean and/or Gulf of Mexico. Whenever this chart appeared, the tons listed for a particular commodity were added to the tons for that commodity listed in the domestic chart, in the appropriate direction (e.g., imports were added to the "in" tonnages in the domestic chart).

In addition to the above data, CONSAD was provided with BEA-BEA and PE-PE movement data on all commodities for the years 1969-1976, and data on the 71 lock and dam projects by commodity group and direction as far back historically as existed. The former data set was provided on tape and the analysis of this information will be discussed in Section 2.4.1, below. The latter data set included data for the key navigation projects for which separate independent projections of future commodity group flows were to be made. In order to make these projections this data has to be coded, and in doing so, a major problem was encountered.

Although the analysis was supposed to be performed by direction (upbound-downbound), much of the annual traffic data was available only in aggregate (combined upbound-downbound). Faced with this situation, CONSAD, after consultation with the project monitor, decided to perform the projections of traffic passing key lock and dam projects in aggregate.

The three data sets discussed above along with their uses are summarized in Table 2.

2.2 Selection of Independent Variables

Assuming that the patterns of past commodity flows bear some relationship to their future flows, and also assuming that these commodities are moving in response to the economic demands of the Nation, it is believed that quantitative relationships exist between economic indicators and waterway traffic levels. It is expected that these relationships could be determined from historical data using correlation and regression techniques and that these relationships could then appropriately be applied to future economic projections to obtain projections of future demand for waterway traffic.

Ideally, any economic or other demand indicator should provide annual data for the years 1940-1975 and should also be projected for the years 1980, 1985, and 1990. However, in searching for economic indicators that could logically be considered as a driving force behind the movements of a particular commodity or commodity group on the waterways of the Ohio River Basin, it was found that except for GNP and national population, compatability between annual historical data and the projected data was extremely rare. More specifically, we were able to locate numerous annual data series for all types of economic variables, but usually there were no projections in existence based upon the annual series. The projections that we were able to locate were not based upon historical data going as far back as 1940.

After much searching and several conversations with faculty members at Memphis State University who had been involved in a similar task for the Louisville District of the Corps of Engineers,* it was decided

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*Existing and Expected Commodity Flow, Port of Louisville, Kentucky, Allen & Hoshall, Inc., Memphis, Tennessee, December 1977.

Table 2: The Three Sets of Waterway Traffic Data

Data Set	Source	Description	Use
1	Waterborne Commerce of the United States, Part 2 1953 - 1975 Annual Report of the Chief of Engineers, Part 2, "Commercial Statistics" 1940 - 1952	Annual tonnages for each river arranged by commodity and direction	Projection of 1980, 1985 and 1990 system level and individual river level commodity group tonnages.
2	U.S. Army Corps of Engineers, Huntington District	1969 - 1976 BEA-BEA and PE-PE O-D flows for each commodity	Test reliability of using basinwide projections as a means of determining future localized traffic flows.
3	U.S. Army Corps of Engineers, Huntington District	Historical lock and dam data arranged by direction and commodity group.	Test reliability of using basinwide projections as a means of determining future localized traffic flows.

that our best source would be the Bureau of Economic Analysis in the U.S. Department of Commerce. The data tapes purchased from BEA included a 37-industry breakdown of earnings, total personal income, per capita income, and population. These categories were provided on an annual basis for the years 1965-1975 and included both national and BEA level data. In addition, a somewhat less detailed data set for thirteen SMSA's on or near the rivers in the study area was also obtained.

All of the above data sources are compatible with the OBERS Projection Series* prepared by the Bureau of Economic Analysis in conjunction with the Economic Research Service in the Department of Agriculture for the U.S. Water Resources Council. In addition to the projected earnings, income, etc., for the years 1980, 1985, and 1990, this series also provides observed historical data for the years 1950, 1959, and 1962. This brings the number of available historical observations up to fourteen.

2.3 Regression Procedures

2.3.1 System

It was necessary initially to aggregate the Waterborne Commerce data set from an individual river format to a "total system" format for each of the nine commodity group categories specified by the Corps. This was accomplished by summing the tonnages for all six directions on the Ohio River together with the tonnages for the two intra-river directions (up and down) for each of the seven tributaries. In this manner all ORB traffic was aggregated without any double counting (see Table 3 and Figures 1, 2 and 3).

After aggregation, a severe drop in crude petroleum shipments for the system as a whole was discovered. This decrease was found to correspond with the opening of a pipeline used for the transport of crude

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*1972 Series E OBERS Projections Series, Bureau of Economic Analysis, Department of Commerce.

Table 3: Historic ORB Waterborne Commerce Traffic by Commodity Group

Year	Coal and Coke	Petroleum Fuels	Crude Petroleum	Aggregates	Grains	Chemical and Chemical Fertilizers	Ores and Minerals	Iron Ore and Iron and Steel	All Other
1940	33653221.	2909150.	1157586.	9164983.	106721.	376281.	180750.	2480618.	1146015.
41	35864313.	3983719.	1666201.	11365822.	157342.	441495.	230682.	2531329.	1911753.
42	40012242.	3867209.	2426228.	10474360.	139057.	437322.	277730.	2012994.	1493706.
43	36613219.	4402362.	3213251.	6968644.	178550.	590862.	304189.	2226144.	1191574.
44	37301797.	4861068.	3882885.	5741163.	204841.	934068.	433242.	2060342.	1334856.
45	32928914.	4689839.	3746904.	6216879.	153930.	657683.	416924.	1507529.	941983.
46	30937197.	4535111.	3582520.	9224714.	83158.	422250.	203283.	1411354.	911639.
47	38850696.	5227566.	3690493.	10464259.	88468.	449945.	336674.	1825012.	785530.
48	37422211.	6305102.	4053452.	11026784.	93039.	781490.	316782.	1915360.	1025556.
49	31556233.	7215616.	3935108.	10240300.	112871.	946895.	647093.	2008142.	792427.
50	37254031.	8553240.	3203268.	11251025.	171372.	1230080.	591011.	2741195.	1098418.
51	42408014.	9587477.	2928075.	14342769.	203697.	1806340.	708241.	2465951.	1059585.
52	39409386.	10044602.	3170963.	14728096.	236218.	1563897.	1122253.	2738547.	1368605.
53	48704394.	10208895.	2969488.	13495115.	385991.	1843011.	1566589.	3761432.	1588057.
54	45726519.	9802307.	3027992.	12507562.	421133.	1572451.	1213475.	5025302.	1514265.
55	62914396.	10777586.	2864853.	13475658.	657225.	1955170.	1796097.	5279895.	2445506.
56	66394738.	11233569.	2926939.	13945536.	619092.	2166045.	1913626.	5535860.	2805912.
57	69399768.	11440048.	3642249.	13969891.	973907.	2429386.	1816644.	5497392.	3360996.
58	57290147.	10945971.	3630970.	13394035.	1443593.	2394899.	1601611.	3965561.	3650048.
59	58324054.	12001939.	3747060.	15079625.	1767185.	3109624.	1353398.	4541085.	4279373.
60	59723600.	11596523.	3590388.	14440500.	2016061.	3653030.	1294445.	4523763.	4479092.
61	59548286.	12070213.	3810400.	14512720.	1861847.	4027879.	1475642.	3921582.	3727667.
62	61720067.	12253949.	4078023.	16253821.	2532425.	4317302.	1798154.	3622595.	4399973.
63	66377742.	12763834.	4373437.	17336819.	2250162.	4848217.	2273793.	3761465.	4671010.
64	73616822.	13189132.	4356945.	19422407.	2081235.	5538629.	2684361.	4015085.	5040404.
65	75368817.	13679599.	4606125.	19642129.	2546130.	6265385.	2823672.	4367361.	7296716.
66	78062467.	12986509.	5049399.	20492598.	2950777.	6893625.	3426253.	4112903.	7713890.
67	82621261.	13425813.	5106372.	20134208.	3181953.	7886535.	3614260.	4001858.	7412373.
68	82602124.	14409520.	5783364.	22451218.	2815568.	8679408.	3747981.	4161646.	8036920.
69	85871369.	14706992.	6593121.	22734941.	3257257.	9890301.	3472931.	4157866.	8179054.
70	88246071.	15544061.	7090095.	21144359.	3372872.	10803953.	3915652.	5193803.	8592326.
71	83102598.	16367258.	7956525.	23141823.	4028188.	11401819.	4437398.	4476043.	9002268.
72	92613201.	17561585.	7811080.	21637209.	3149999.	11337379.	3611911.	5388586.	8571801.
73	90208646.	17895761.	4220387.	22626062.	3015348.	10591076.	3067275.	5407139.	9073407.
74	90896324.	18957802.	643902.	22098178.	3555047.	11610126.	3753813.	5124604.	10779656.
75	98236949.	18845996.	867053.	19666204.	4097296.	9354147.	3445572.	4161532.	10315964.

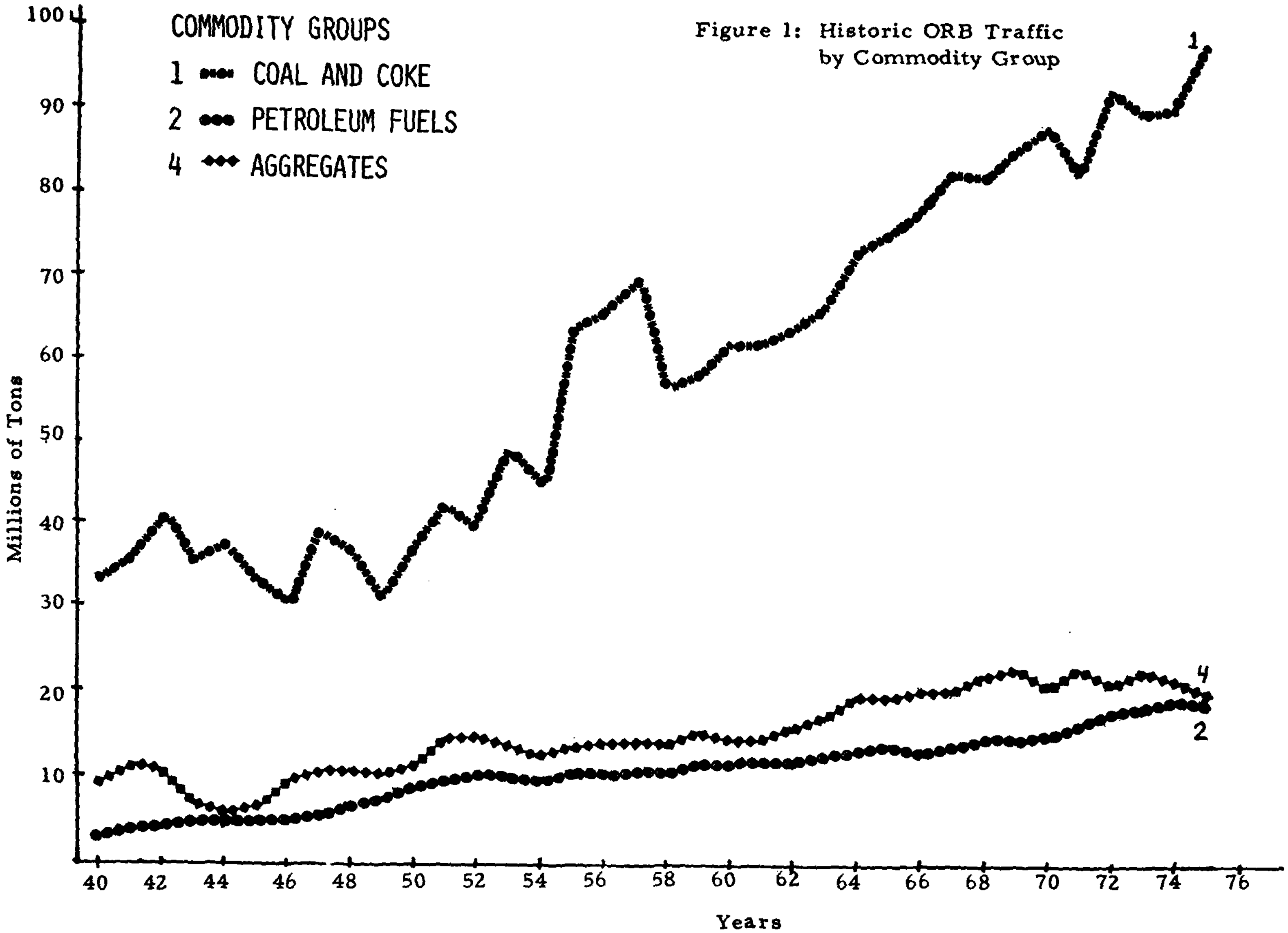

Figure 1: Historic ORB Traffic
by Commodity Group

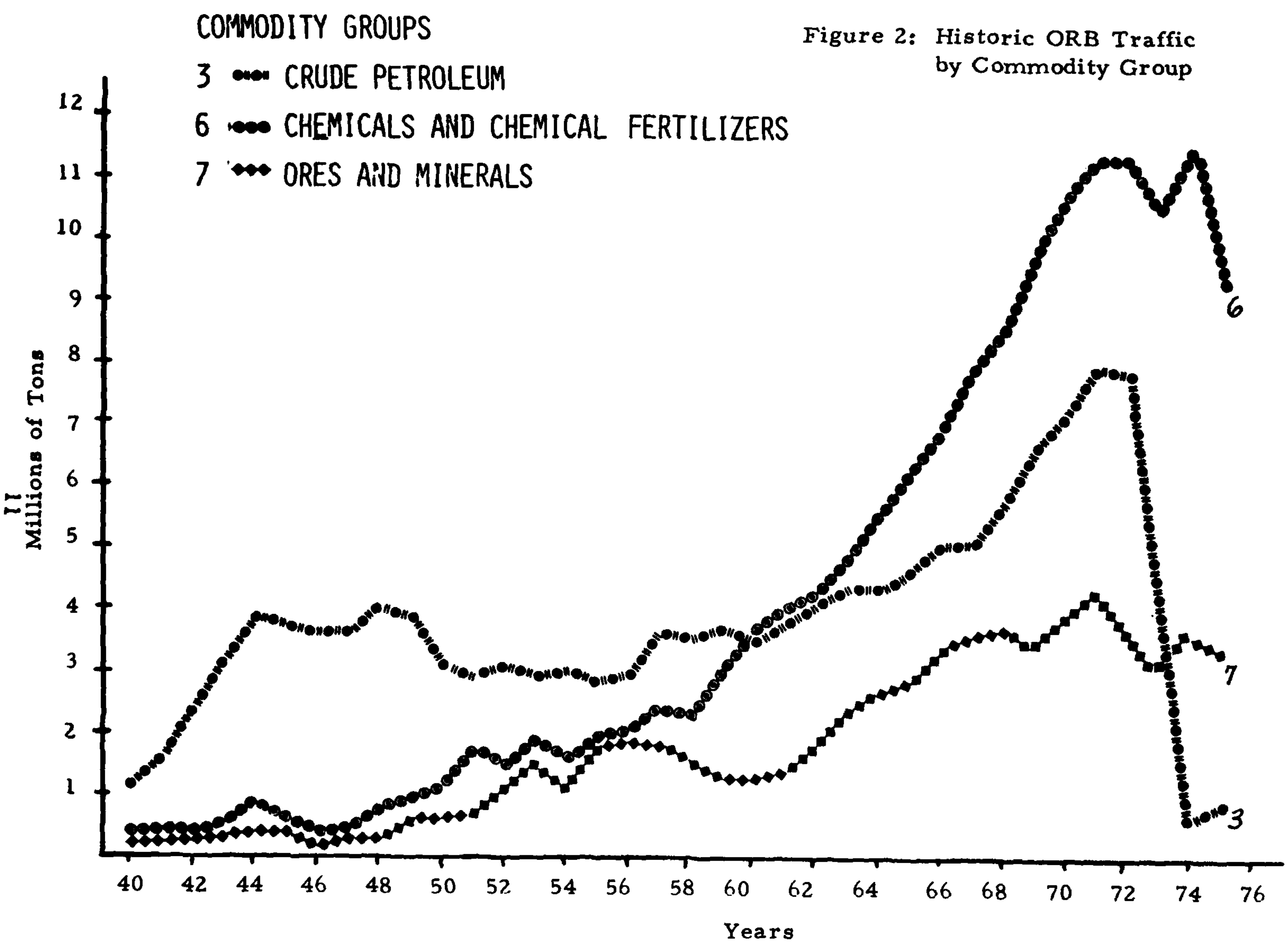

Figure 2: Historic ORB Traffic by Commodity Group

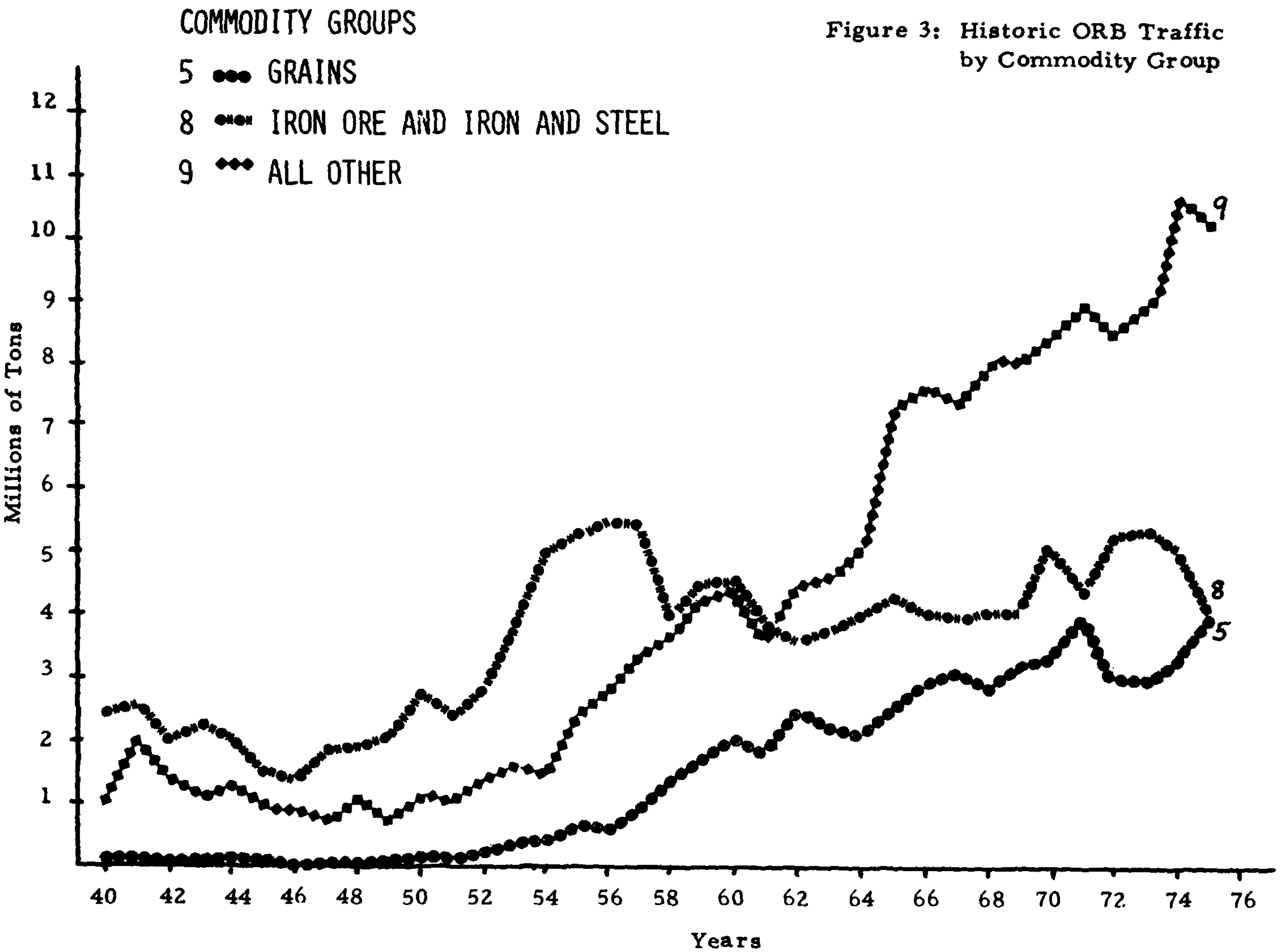

Figure 3: Historic ORB Traffic by Commodity Group

petroleum. Regression procedures were abandoned for this commodity group in favor of other means of determining future shipments (see Section 3.1.1 for details).

The first step in the regression procedure for the other eight commodity groups was to develop a series of regression equations based on the complete set of 36 years of historical data for each of the nine commodity groups. The functional forms utilized were:

1. Straight line: $Y = a + bX$

2. Second degree curve: $Y = a + bX + cX^2$

3. Geometric curve: $Y = a \cdot X^b$

4. Exponential curve: $Y = a \cdot b^X$

In addition to a time series, regression runs were made using Gross National Product and national population as independent variables (36-year series). At this stage severe problems of multicollinearity arose. The correlations between time and GNP and time and national population were .99062 and .99772, respectively. The correlation between GNP and population was .98400. This degree of correlation eliminated the idea of using any multivariate regression equations at this level of analysis. It was decided that a simple regression using GNP as the independent variable would be the best procedure under these circumstances. The equations retained for analysis and the projected commodity group tonnages they yield appear in Section 3.1.1, Tables 7-14.

The criteria employed for retention of a regression equation were goodness of fit (R^2) and "appropriateness" of the projected tonnage. By "appropriateness" we mean whether or not the projected value seemed reasonable in light of the historic tonnage values. As an example, an equation predicting a ten-fold increase in the tonnage of grains moving on the Basin's waterways, where traffic data and transport developments would not indicate such growth, would be rejected, despite a high R^2 value.

The next group of independent variables tested were national level income and earnings figures. These variables are listed in Table 4.

Table 4: Definition of Independent Variables Considered in the Analysis

	National Level	Basin Level
Gross National Product	XN01	---
Population	XN02	XB02
Total Personal Income	XN03	XB03
Per Capita Income	XN04	XB04
Total Earnings	XN05	XB05
Earnings in Agriculture	XN06	XB06
Earnings in Mining	XN07	XB07
Earnings in Coal Mining	XN08	XB08
Earnings in Manufacturing	XN09	XB09
Earnings in Manufacture of Food and Kindred Products	XN10	XB10
Earnings in Manufacture of Chemicals and Allied Products	XN11	XB11
Earnings in Petroleum Refining	XN12	XB12
Earnings in Manufacture of Primary Metals	XN13	XB13
Earnings in Manufacture of Fabricated Metals	XN14	XB14
Earnings in Transportation, Communication & Utilities	XN15	XB15
Earnings in Wholesale & Retail Trade	XN16	XB16
Earnings in Contract Construction	XN17	XB17

As was noted above, this data included annual values for 1965 through 1975 plus a few prior selected years; the number of observations (data points) thus dropped to fourteen at this stage of the analysis.

Rather than allow the computer to choose among this rather long list of variables, an initial screening was undertaken. For each commodity group, in addition to the more general variables (Total Personal Income, Per Capita Income, Total Earnings) which were tested for all commodity groups, several "specifically targeted" variables were also chosen. More precisely, only those variables which possessed some identifiable economic relationship to the commodities in a particular commodity group were included in the analysis. Table 5 lists the choices of independent variables tested by commodity group.

Multicollinearity again presented a problem. Except for XN06, XN07 and XN08 only two correlation values of less than .9 were found between pairs of variables. To deal with this situation the SPSS* stepwise regression package was utilized. This package allows the user to specify a set of three statistical criteria to be used in screening variables for inclusion in the equation. These parameters are the number of variables, the minimum acceptable F-test value, and the minimum acceptable tolerance level which refers to the proportion of the variance of a variable being considered for inclusion not explained by the variables already in the regression equation.

The maximum number of variables to be allowed was chosen at three. The minimum F-test value was set high enough so that given the number of observations and variables in the equation, there was a 95 percent probability that the coefficient associated with a particular variable was significant. Finally the tolerance level was set at .01, meaning that a variable would be entered only if the proportion of its variance not explained by the other variables exceeded one percent. Results from this computer run also appear in Section 3.1.1, Tables 7-14.

A third series of independent variables tested consisted of basin level income and earnings figures. To construct these variables, data

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*"Statistical Package for the Social Sciences", Norman H. Nie, C. Hadlai Hull, Jean G. Jenkins, Karin Steinbrenner, Dale H. Bent, McGraw-Hill Book Company, Second Edition, 1975.

Table 5: National and Basin Level Independent Variables Tested by Commodity Group

	Gross National Product	Population	Total Personal Income	Per Capita Income	Total Earnings	Earnings in Agriculture	Earnings in Mining	Earnings in Coal Mining	Earnings in Manufacturing	Earnings in Manufacture of Food and Kindred Products	Earnings in Manufacture of Chemicals and Allied Products	Earnings in Petroleum Refining	Earnings in Manufacture of Primary Metals	Earnings in Manufacture of Fabricated Metals	Earnings in Transportation, Communication and Utilities	Earnings in Whole-sale and Retail Trade	Earnings in Contract Construction
Commodity Group 1 - Coal and Coke	N	NB	N	N	N		N	NB	NB		NB		NB	NB	NB		
Commodity Group 2 - Petroleum Fuels	N	NB	N	N	N							NB			NB		
Commodity Group 4 - Aggregates	N	N	N	N	N								NB	NB			NB
Commodity Group 5 - Grains	N	N	N	N	N	NB				NB						NB	
Commodity Group 6 - Chemical and Chemical Fertilizers	N	N	N	N	N	NB			NB		NB						
Commodity Group 7 - Ores and Minerals	N	N	N	N	N		NB		NB				NB	NB			
Commodity Group 8 - Iron Ore and Iron and Steel	N	N	N	N	N		NB	NB					NB	NB			NB
Commodity Group 9 - All Other	N	N	NB*	N	NB*				NB							NB	

N - National Level
B - Basin Level

*At the basin level, two separate runs were made in an attempt to include only one of the "general" variables, XB03 and XB06. The equation yielding the better fit was chosen.

from the thirteen BEA areas which cover the study area (see Figure 4) were aggregated. These variables are also listed in Table 4.

Initial inspection of these variables indicated that the multicollinearity situation was much less severe, with many of the correlations between pairs of independent variables lying in the .6 to .9 range.

At this level of analysis it was decided that the independent variables entered into the stepwise regression program would be restricted to the commodity specific variety except where the more general variables seemed particularly appropriate (e.g., basin population as a demand indicator for petroleum fuels). This decision was made in an attempt to provide the best possible direct relationship between the commodity group and the explanatory variable(s). For a complete list of the basin level varibles tested, by commodity group, see Table 5. The rationales for the pairing of specific independent variables with each commodity group are provided in Table 6.

It was also decided that the restrictive minimum F-test level for variable inclusion would be somewhat eased so as to allow variables that had rather direct relationships to the commodity groups into the regression equation even if their coefficients did not quite reach the 95 percent significance level. Results from this basin level analysis are given in Section 3.1.1, Tables 7-14.

Of the nine commodity groups analyzed in this study, Commodity Group 1, Coal and Coke, has historically accounted for the most significant portion of total traffic (see Table 3). Within this group, steam coal, used to generate electricity, is by far the most important commodity (by tonnage). A "good" single indication of steam coal demands was not identified within the OBERS framework, and the industry specific variables included in the regression procedures represent secondary demand variables since these industries tend to be major enery users.

Because of the significance of steam coal to this projection study, it was felt that some additional "sensitivity" testing was called for. Under the assumption that Earnings in Transportation, Communication, and Utilities provides the best single indication of direct demand for steam coal, and also assuming that Population and Earnings in Manufacturing provide the best secondary demand indicators for non-commercial and commercial use of electricity, respectively, regression procedures were undertaken in which Earnings in Transportation,

Communication and Utilities was forced into the equation, followed by either or both of the other two variables. The projections which resulted from the equations developed in this manner were remarkably close to the projections obtained as a result of the regression procedures described earlier in this section. At both the national and basin levels, Population and Earnings in Manufacturing yielded insignificant F-test values when entered into the equation after Earnings in Transportation, Communication and Utilities. Utilizing the single independent variable equations, coal and coke tonnage was projected at $174\frac{1}{2}$ million tons (national level data) and 181 million tons (basin level data) in 1990. Comparison with the projections in Table 60 shows a 3 million ton difference at the national level and slightly over a million tons at the basin level.

These results suggest that coal and coke projections are rather insensitive to the choice of OBERS variables utilized in the regression equation. They also add a degree of confidence to the reliability of the projections.

2.3.2 Individual Rivers

The subsystem regression procedures described in this section and in the following section (2.3.3 Key Lock and Dam Projects) were undertaken primarily as a means of determining whether traffic on the system components are moving in response to the same demand variables and with similar correlations as is occurring at the system level. Since the ultimate goal of this study is to arrive at projections of demand for future lock and dam traffic, and because these projections will be determined as a result of system level analysis modified by recent subareal O-D trends, it was felt that a subsystem analysis would be of value in determining the reliability of allocating systemwide projections to the subsystems (individual rivers and lock and dam projects).

Figure 4: ORB Showing Rivers and BFA Regions

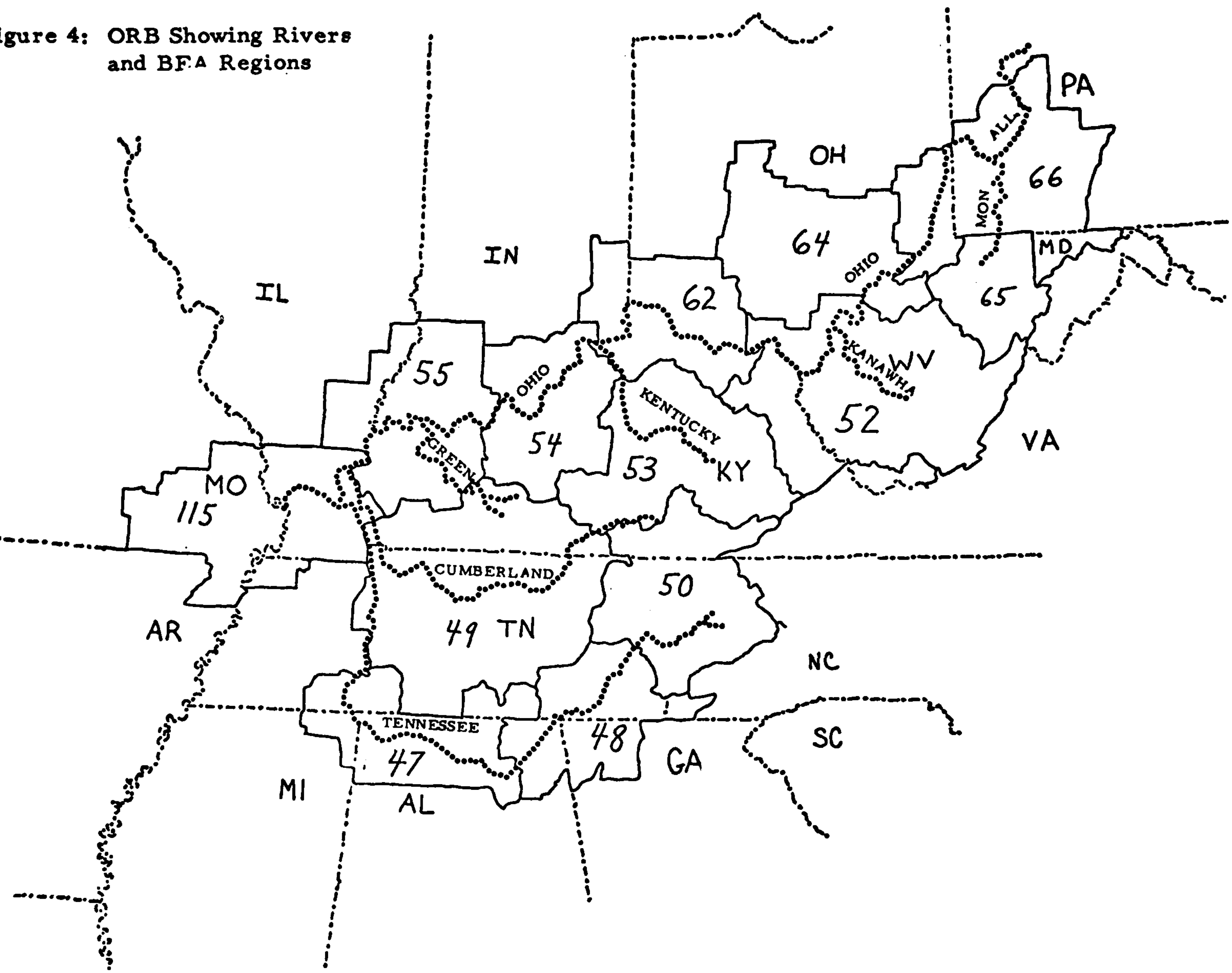

Table 6: Rationale for Pairing of Independent Variables with Commodity Groups

Dependent Variable: Traffic by Commodity Group	Independent Variable: Economic Factor Tested	Relationship Between Commodity Group and Independent Variable
1. Coal and Coke	Earnings in Coal Mining	Increase or decrease in coal mining earnings may correspond to an increase or decrease in the tonnage of coal on the waterways of the ORB
	Earnings in Transportation, Communication, and Utilities	Steam coal for generation of electricity is the primary use of the coal shipped on ORB waterways
	Earnings in the Manufacture of Chemicals and Allied Products	In addition to the electricity consumed in the manufacturing process, some of the chemicals and associated by-products have a coal base
	Earnings in the Manufacture of Primary Metals	Coal and coke are essential ingredients in the production of iron and steel
	Earnings in the Manufacture of Fabricated Metals	This represents a secondary demand variable since fabricated metals are fashioned from primary metals
	Population	Intended to provide the best general demand indicator for non-commercial use of electricity
	Earnings in Manufacturing	Intended to provide the best general demand indicator for commercial use of electricity
2. Petroleum Fuels *	Population	The population of an area determines the demand for home heating fuel and gasoline for automobiles
	Earnings in Petroleum Refining	Reflects levels of activity at petroleum refineries which would relate to volume transported
	Earnings in Transportation, Communication, and Utilities	Petroleum fuels power transport vehicles and are used to generate electricity
4. Aggregates	Earnings in the Manufacture of Primary Metals	This commodity group includes limestone flux, an important ingredient in iron and steel production
	Earnings in the Manufacture of Fabricated Metals	This is a secondary demand variable since fabricated metals are fashioned from primary metals
	Earnings in Contract Construction	Building stone, sand, gravel, and crushed rock are used in construction work
5. Grains	Earnings in Agriculture	Tonnage of grains moving on ORB waterways may correspond to agricultural earnings
	Earnings in the Manufacture of Food and Kindred Products	Grains are milled and used in many types of foods
	Earnings in Wholesale and Retail Trade	Sales of grains, meat (grain-fed animals), and numerous soybean products relate to the demand for grains
6. Chemicals and Chemical Fertilizers	Earnings in Agriculture	Agriculture industry consumes a great deal of chemical fertilizers and pesticides
	Earnings in Manufacturing	Dyes, plastics, synthetic rubber and fiber paints, and other chemicals are consumed in various manufacturing processes
	Earnings in the Manufacture of Chemicals and Allied Products	Earnings by these industries should relate to the tonnage of chemicals and fertilizers on ORB waterways

Table 6 (continued)

Dependent Variable: Traffic by Commodity Group	Independent Variable: Economic Factor Tested	Relationship Between Commodity Group and Independent Variable
7. Ores and Minerals	Earnings in Mining	Levels of earnings of the mining of various ores and minerals should correspond to levels in the tonnage of ores and minerals on ORB waterways
	Earnings in Manufacturing	Nonferrous metal ores, salt, sulfur, and gypsum are used in the manufacture of a variety of goods
	Earnings in the Manufacture of Primary Metals Earnings in the Manufacture of Fabricated Metals	Copper, bauxite, manganese, and other nonferrous metal ores are used in the manufacture of various primary and fabricated metals
8. Iron Ore and Iron and Steel	Earnings in Mining Earnings in Coal Mining	Earnings in the mining of coal, iron ore, and limestone may relate to the tonnage of iron ore and iron and steel on ORB waterways
	Earnings in the Manufacture of Primary Metals	Earnings in iron and steel industries may relate to the tonnage of this commodity group on ORB waterways
	Earnings in the Manufacture of Fabricated Metals	A secondary demand variable since iron and steel are fashioned into numerous fabricated metal products
	Earnings in Contract Construction	Many steel products (girders, concrete reinforcing rods, pipes, etc.) are used by the construction industry
9. All Other	Total Personal Income Total Earnings Earnings in Manufacturing Earnings in Wholesale and Retail Trade	This commodity group is made up of all commodities that were not listed in the other groups, and therefore covers a wide variety of goods. Total personal income is intended to provide a demand index to the amount of money people have available for consumption of essential and non-essential goods. Total earnings should relate to the overall demand for raw materials and semi-finished goods by the industrial sector. Earnings in manufacturing and wholesale and retail trade are somewhat more specific in that they relate to the demand for the inputs to the many manufacturing processes and goods for sale, respectively.

* **A small portion of the ORB petroleum fuels are used in both manufacturing and energy production processes. However, this was judged not to be a significant demand indicator.**

At the individual river level, the analysis was to be performed by direction (upstream-downstream) and commodity group. Given the format used in coding the data, it was quite simple to aggregate the data into upstream and downstream categories for the seven tributaries under study. For the Monongahela, Allegheny, Kanawha, Kentucky, and Green Rivers, the upstream category was created by summing the "up" and "in" river categories, while the downstream category consisted of the sum of the "down" and "out" categories. For the Cumberland and Tennessee Rivers, the upstream category consisted of the sum of "up, in" and "up-through" categories, and the downstream category consisted of the sum of "down, out" and "down-through" categories.

Matters were not quite as simple in the case of the mainstream Ohio River. "In-river" and "out-river" do not specify a direction on the Ohio since commodities can enter or leave the Ohio either at the mouth (Mississippi River) or at any one of the tributaries. Therefore, it was decided that a third directionless category (titled "other") would be created consisting of the sum of "in-river" and "out-river" traffic. The "upstream-downstream" categories were also retained, but in this case consisted of "up" plus "up-through" and "down" plus "down-through" categories, respectively.

The data aggregations described above appear in Appendix B.

In an attempt to identify the degree of association between the behavior of the total Ohio River navigation system and its components, the same independent-dependent variable relationships tested at the system level* were also tested at the individual river level for each commodity group and river, by direction (see Table 5).

At this level of analysis only linear regression procedures were undertaken using the SPSS stepwise regression package described in the previous section of this report. The decision to eliminate the other functional forms was based on the fact that CONSAD had already decided to use

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*No analysis utilizing the national level income and earnings data (fourteen years) was undertaken.

the linear regression equations to project future commodity group tonnages at the system level. Since this subsystem component analysis was intended primarily as a check of the relationship of the system as a whole to the system components, we saw no reason to continue with the nonlinear forms of analysis.

In an attempt to determine whether traffic on the individual rivers was moving in response to more localized variables, additional regression procedures were undertaken. For the Allegheny and Monongahela Rivers, independent variables based solely on BEA 66 were used. For the Kanawha River, BEA 52 variables were tested. These river-BEA relationships are geographical in nature, i.e., the Allegheny and Monongahela Rivers are located mostly within BEA 66 and the Kanawha River is located in BEA 52 (see Figure 4). The same commodity group - industry earnings relationships utilized at the basin level were retained at the BEA level. Both the basin level and BEA level independent variable regression results appear in Section 3.1.2.

2.3.3 Key Lock and Dam Projects

Of the 71 navigation projects in the ORB there were ten projects (three on the Ohio River, one each on the seven tributaries) that were chosen by the Corps of Engineers for analysis in this study (see Table 37 for listing). For these ten projects, separate, independent projections of future traffic were to be made for the three major commodity groups transiting each project. Examination of the historic data provided by the Corps showed the two of the projects only handled a single commodity group, and in several cases it was difficult to distinguish the "top three", based on the historic tonnages. The final commodity groups chosen for analysis for each project also appear in Table 37.

The data was provided by commodity group and direction, but, as was mentioned earlier, the directional distinction was not always preserved and the projections had to be done in aggregate, rather than by direction. The projection procedures employed for these lock and dam projects were similar to those utilized for the individual river projections.

Again, equations obtained using basin level independent variables were tested first. The same commodity group specific independent-dependent variable relationships tested at the system and individual river level were also used for the key lock and dam project demand regressions.

In an attempt to determine whether traffic passing through the key lock and dam projects was moving in response to more localized variables, additional regression procedures were undertaken. Specifically L&D #2 on the Allegheny River and L&D #7 on the Monongahela River were tested against BEA 66 variables, and the Winfield L&D on the Kanawha River was tested against BEA 52 variables. Both the basin level and BEA level independent variable regression results appear in Section 3.1.3.

2.4 Origin-Destination Movements

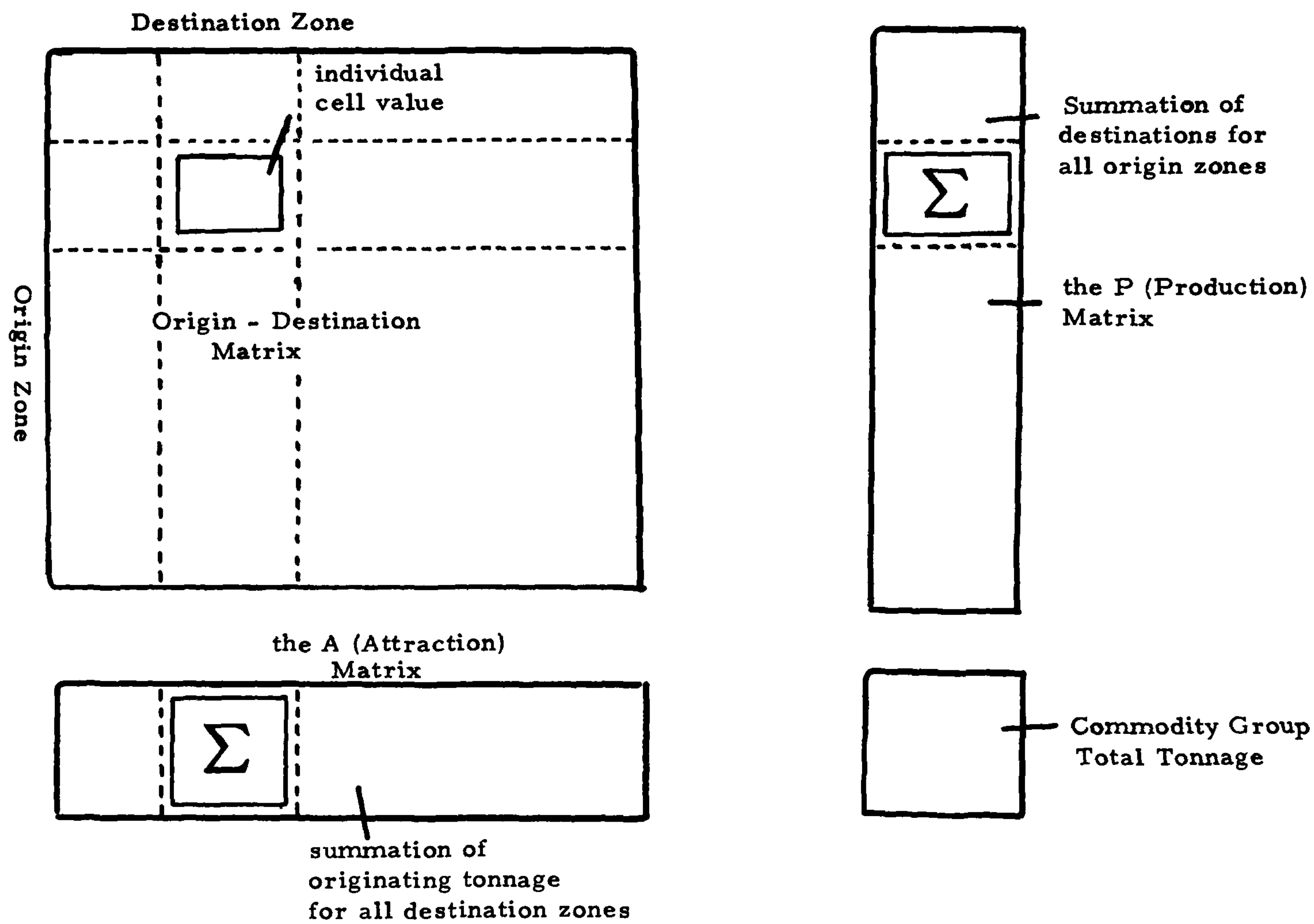
2.4.1 Preliminary Examination of O-D Movements

Given eight years of O-D movement data by commodity, both at the BEA and PE level, it was decided that a preliminary data inspection was called for prior to undertaking any analysis. Therefore, a computer printout was obtained such that for each commodity group and year, two matrices were constructed. The first was arranged so that for each origin BEA a complete list of destinations was printed along with the associated tonnages and the percent of the total shipped from that BEA represented by that tonnage. In addition, the total tonnage shipped from each BEA and the percent of total commodity group tons for the basin represented by that tonnage also appeared. The second matrix was arranged similarly, but for destination BEA's. In all cases eight years worth of data were examined so as to observe trends.

From the above printout two types of tables were assembled, representing two levels of analysis. For clarification on these two types of tables the reader is referred to Figure 5 , which shows the components of an origin-destination matrix and several related vectors. The first type of table essentially displays the P and A (Production and Attraction) Matrices, over time, for each commodity group. This shows the relative importance of each zone (BEA Region) within the Basin and how this has varied with time.

The second type of table, displays the distribution of the individual cell values for each element of the P and A matrix, and how that has varied in time. This table shows shifts in movements beyond those which occur due to differences in production and attraction rates over time.

Figure 5: Schematic of Relationships in an Origin - Destination Matrix



At the more aggregated level, (the P and A Matrices) for each commodity group, a list of origin BEA's, the tonnages shipped from each, and the percent of total commodity group tons represented by that tonnage for each of the eight years between 1969 and 1976 (inclusive) is displayed. At the top of the table, for each year, a percent, representing what part of the total tons of a particular commodity group originated in the ORB also appeared. Similar tables were constructed for destination BEA's.

Next, for commodity groups 1, 2 and 4, historically representing between 75 and 80 percent of all Basin traffic, an analysis of the destinations of major shipping BEA's and the originations of receiving BEA's was undertaken, and the second type of table was also constructed. More specifically, for each origin BEA shipping a substantial tonnage of a commodity group, the top five destinations, tonnage destined for each, and percent of total orginating tonnage represented by that destined tonnage over the eight year period were listed. A similar representation is provided for destination BEA's.

All tables described above appear in Appendix D; the first type of table carries the designation "P/A", while the second type is designated by "O/D". It is important to note the connection between each series of tables. The total tonnage figure appearing in the bottom row of the latter series of tables described above is equal to the tonnage figure appearing in the former series of tables in the corresponding year and BEA position.

In order to further clarify the preceding discussion, two tables (one of each type) from Appendix D appear on the following pages. The first table displays the annual tonnage of Commodity Group 1 shipped from each BEA between 1969 and 1976. Immediately below each tonnage a number appears which represents the percent of all Commodity Group 1 shipments involving the ORB that were shipped from that particular BEA.

The second table provides a breakdown of the BEA 66 shipments (first row of first table), answering the question "What were the destinations of the BEA 66 coal and coke over time?" The destination BEA as well as the number of tons and the percent that the tonnage represents compared to the total shipped from that BEA are included.

For instance, in 1972 BEA 66 shipped 28,579,605 tons of coal and coke (first table, first line). This represents 30.35 percent of all coal

COMMODITY GROUP 1

Sample 1

P/A

Origin BEA	'69 99.97	'70 99.87	'71 99.72	'72 99.12	'73 98.55	'74 97.80	'75 97.12	'76 97.33
66	30,960,310 35.60	30,854,945 34.40	25,131,806 29.67	28,579,605 30.35	29,310,959 32.01	31,863,731 34.42	32,634,377 32.75	32,222,877 31.14
55	24,374,782 28.03	25,655,552 28.60	21,918,438 25.87	26,376,685 28.01	27,845,409 30.41	28,847,045 31.17	30,246,576 30.35	27,823,052 26.89
52	17,344,977 19.95	17,126,000 19109	21,420,455 25.29	19,335,633 20.53	17,255,945 18.85	16,106,348 17.40	18,067,656 18.13	22,930,023 22.16
65	8,458,116 9.73	10,204,430 11.38	8,289,818 9.79	9,991,744 10.61	8,856,340 9.67	7,826,971 8.46	8,295,370 8.32	6,147,927 5.94
115	2,883,082 3.32	2,684,443 2.99	4,411,122 5.21	5,311,501 5.64	3,838,217 4.19	2,620,889 2.83	1,975,091 1.98	3,165,405 3.06
47	1,329,066 1.53	1,394,265 1.55	1,181,147 1.39	1,332,719 1.42	1,326,324 1.45	1,295,654 1.40	1,466,772 1.47	2,851,359 2.76
48	1,172,802 1.35	1,434,523 1.60	1,809,228 2.14	1,877,610 1.99	1,427,915 1.56	1,346,902 1.46	1,456,851 1,46	1,420,281 1.37
64	190,800 .22	33,611 .04	37,824 .04	95,366 .10	105,573 .12	253,250 .27	848,889 .85	592,788 .57
49	159,600 .18	72,900 .08	-	-	-	-	-	-
54	56,230 .06	129,143 .14	263,590 .31	433,577 .46	201,256 .22	162,311 .18	1,572,872 1.58	2,043,157 1.97
62			5,929 .01	7,268 .01	62,906 .07	191,340 .21	232,528 .23	1,519,862 1.47

Sample 2

Origin BEA 66 — **Top 5 Destinations, Destination Tonnage and % of Total Originating Tonnage**

	1969	1970	1971	1972	1973	1974	1975	1976
1	66 27508542 88.85	66 27477486 89.05	66 21591733 85.91	66 24368288 85.26	66 25080517 85.57	66 25413760 79.76	66 24415123 74.81	66 26346785 81.76
2	52 2864903 9.25	52 2447140 7.93	52 2073200 8.25	62 2308212 8.08	62 2331522 7.95	62 4220743 13.25	62 4366062 13.38	62 3447179 10.70
3	62 330344 1.07	62 791380 2.56	62 1405498 5.59	52 1845700 6.46	52 1832113 6.25	52 1979903 6.21	49 1933098 5.92	52 1765226 5.48
4	64 125130 .40	115 58199 .19	115 23137 .09	89 15296 .05	64 37580 .13	114 108434 .34	52 1852449 5.68	49 454627 1.41
5	77 21894 .07	64 57799 .19	64 18429 .07	64 13316 .05	115 10895 .04	137 60418 .19	65 28820 .09	65 81936 .25
Total Originating Tonnage	30960310	30854945	25131806	28579605	29310959	31863731	32634377	32222877

Commodity Group 1

O/D

and coke shipments involving the ORB in 1972. Referring to the second table, one can determine that 85.26 percent or 24,368,288 tons remained in BEA 66, 8.08 percent or 2,308,212 tons went to BEA 62, and so on. In this manner one can follow the O-D patterns through time at the BEA level for Commodity Groups 1, 2 and 4.

2.4.2 Obtaining Future O-D Movements: Shift-Share Analysis and the Fratar Method

After examination of the eight years of O-D movement data, it was decided that the most appropriate technique for extrapolating the historic O-D movement trends to 1980, 1985 and 1990 O-D flows was to utilize Shift-Share analysis in conjunction with the Fratar Growth-Factor method. This decision was made in light of the overall stability in the patterns of O-D movements (see Appendix D). Both of these techniques are well suited for extrapolation purposes when no severe changes in historic patterns are anticipated.

Shift-Share analysis,* given historic movement patterns and projections of future commodity group activity (see Section 3.1.1), develops future shipping and receiving (O and D) totals for each commodity group and subarea (BEA or PE). These totals correspond to row and column sums of a commodity-specific O-D matrix. The Fratar technique** will then construct the future matrix cell entries according to a base year pattern adjusted by subareal growth factors.

More specifically, the Shift-Share methodology acts recursively on a series of commodity group specific O-D matrices. Each subarea is examined in light of the total originating shipments (row sum of O-D matrix) and total destinations (column sum). Shift-Share analysis interprets subareal growth as dependent upon two "parent forces": growth in total

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*Dunn, E.S., Jr., "A Statistical and Analytical Technique for Regional Analysis", Papers, Regional Science Association, 6(1960), 97-112.
**Hutchinson, B.G., Principles of Urban Transport Systems Planning, Washington, D.C.: Scripta Book Company, 1974, pp. 84-85.

shipments and growth in the commodity group shipments between successive time periods. Any growth inconsistent with those parent forces is attributed to unique subareal characteristics.

At this point in the discussion it becomes convenient to introduce mathematical notation to facilitate the description of the Shift-Share methodology. We define the following:

Q_{ij}^{gt} = = total annual tonnage of commodity group g originating from subarea i and terminating at subarea j in year t (O-D matrix cell entry).

$O_i^{gt} = \sum_{j=1}^{n} Q_{ij}^{gt}$ = total annual tonnage of commodity group g originating from subarea i in year t (row sum of O-D matrix: the P matrix).

$D_j^{gt} = \sum_{i=1}^{m} Q_{ij}^{gt}$ = total annual tonnage of commodity group g terminating in subarea j in year t (column sum of O-D matrix: the A matrix).

$$Q^{gt} = \sum_{i=1}^{m} O_i^{gt} = \sum_{j=1}^{n} D_j^{gt} = \sum_{i=1}^{m} \sum_{j=1}^{n} Q_{ij}^{gt}$$

= total annual tonnage for commodity group g.

$Q^t = \sum_{g=1}^{9} Q^{gt}$ = total annual tonnage in year t.

Then between successive years the incremental growth in shipments* for commodity group g in subarea i (ΔO_i^{gt}) is seen by shift-share as being comprised of the following three components:

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*A similar analysis is performed for the D_j^{gt}'s.

$$\Delta O_i^{gt} = R_i^{gt} + S_i^{gt} + U_i^{gt}$$

where R_i^{gt} = raw increment which would occur if commodity group g in subarea i were to behave as the aggregate regional growth rate for all commodity groups.

S_i^{gt} = any growth (or decline) in commodity group g over and above the regionwide aggregate growth.

U_i^{gt} = the "unique" component: any growth (or decline) in commodity group g within subarea i for which the first two components (R_i^{gt}, S_i^{gt}) take no account.

These components are calculated in the following manner:

$R^{gt} = r^t O^{g(t-1)}$ where $r^t = \dfrac{Q^t - Q^{t-1}}{Q^{t-1}}$, the basinwide growth rate for all commodities.

$S_i^{gt} = (y^{gt} - r^t)\, O_i^{g(t-1)}$

where $y^{gt} = \dfrac{Q^{gt} - Q^{g(t-1)}}{Q_i^{g(t-1)}}$, the basinwide growth rate for commodity group g.

$U_i^{gt} = (z_i^{gt} - y^{gt})\, O_i^{g(t-1)}$

where $z_i^{gt} = \dfrac{O_i^{gt} - O_i^{g(t-1)}}{O_i^{g(t-1)}}$, the growth rate for subarea i for commodity g.

It is the unique growth parameter $z_i^{gt} - y^{gt}$ which we define as u_i^{gt} (excess of commodity specific subareal growth rate over the regionwide commodity specific growth factor) that is calculated for each BEA region, (origins and destinations) for each commodity group, and for each of the seven

iterations covering the years 1969-1976. To arrive at the 1980 u_i^{gt} value, a simple time series regression is performed on the seven historical values. The only other inputs required to obtain the 1980 origin and destination totals are a projected total tonnage figure for 1980 ($\hat{Q}^{t}$*) and projected tonnages for each commodity group ($\hat{Q}^{gt}$). These projected tonnages are taken from the systemwide projections, the value of which are contained in Section 3 of this report.

Procedures for determining the 1985 $\hat{u}_i^{gt}$ growth factors are analogous except the 1980 values are added to the original seven historical values and year t-1 now refers to the projected 1980 tonnages. Similarly, the 1990 $\hat{u}_i^{gt}$ values are calculated from nine values (7 observed, 2 projected) and the year t-1 refers to the projected 1985 tonnages.

Once the subareal growth estimates (ΔO_i^{gt}) have been calculated, they are added to the base year's originating total ($O_i^{g(t-1)}$) to arrive at a future originating total ($\hat{O}_i^{gt}$).

$$O_i^{gt} = O_i^{g(t-1)} + \Delta O_i^{gt}$$

This is done for each of the n subareas so that we now have an n x 1 vector whose entries consist of the raw projected total shipments for each subarea. The sum of these entries should be close to Q^{gt}, the projected commodity group tonnage total. In order to obtain a precise match, we calculate a normalizing factor, K, by comparing the desired value, Q^{gt}, with the calculated total tonnage $\sum_{i=1}^{n} O_i^{gt}$. This should give us a normalizing factor close to 1.0 by which we multiply each of the O_i^{gt} values, finally arriving at future origination totals for each subarea, the sum of which will equal the projected tonnage for that particular commodity group. The mathematics of the normalizing step is represented as follows:

$$K = \frac{Q^{gt}}{\sum_{i=1}^{n} O_i^{gt}}$$

$$\hat{O}_i^{gt} = K \cdot O_i^{gt} \text{ for all i.}$$

*"^" notation refers to projected values.

CONSAD initially planned to perform the shift-share analysis at the BEA level rather than at the PE level. This decision was based upon the assumption that the economic behavior of the BEA region mirrors the economic behavior of the areas within the BEA region. This assumption is consistent with the conceptual basis employed in delineating these BEA areas, which relies on central place theory with its emphasis on cities as the focus around and within which integrated economic activity concentrates. Thus, it would seem reasonable to apply the growth factors calculated for a BEA region to its member PE's.

However, in calculating a growth factor, a necessary input is a future originating tonnage total and terminating total for each PE. If Shift-Share is performed at the BEA level, the future BEA tonnage total will have to be apportioned to the member PE's according to the share of the total BEA traffic which each PE had in the base year. However, this allocation procedure presupposes that each PE in a BEA will continue to ship and receive the same proportion of the traffic allotted for that particular BEA.

Another problem associated with BEA level Shift-Share involves BEA 66 (see Figure 4). This economic region contains 20 of the 71 navigation projects under study and a significant portion of the commodity movements both originate and terminate within this region and are intra-BEA 66 movements. BEA level Shift-Share may not be quite sensitive enough to capture the changes in traffic patterns occurring at the PE level which will have an effect on the projected traffic loads assigned to each navigation project.

CONSAD feels that these weaknesses represent only a small source of error, but after examining the historic O-D movement patterns, it was decided that the utilization of the shift-share methodology at the BEA level for Commodity Groups 1 and 4 would be inappropriate (see Appendix D). This decision was made based on both the amount of intra-BEA 66 movement and the fact that these two commodity groups have historically accounted for approximately two-thirds of the total tonnage moving on the waterways of the ORB. Thus, shift-share was applied at the PE level for these two commodity groups, in an attempt to minimize the error associated with assignments of commodity group tonnages to navigation projects.

In actually applying the Shift-Share methodology to the eight years of O-D flow data it was discovered that extrapolation of the unique growth parameters, u_i^{gt}, by simple time series regression was often inappropriate. Since this growth parameter was defined to be the difference between two other growth factors (z_i^{gt} - y^{gt}), it should not be too surprising that the u_i^{gt} values often did not show any particular trend. Consequently, unless the time series regression yielded an R^2 value greater than .5, a simple averaging of the historical u_i^{gt} values was used to obtain the 1980, 1985 and 1990 unique growth parameters.

Furthermore, examination of resulting origin and destination totals for 1990 showed that time series regressions of u_i^{gt} sometimes yielded negative u_i^{gt} values, resulting in negative tonnages of shipments. Therefore, the regression procedure was abandoned and the historical u_i^{gt} values were averaged after the smallest and largest were removed so that inordinately large increases or decreases in shipments did not overly effect future shipments.

Having developed the future origin and destination totals, i.e., row and column sums of the future O-D matrices, the next step was to construct the actual matrix cell values representing commodity flows from a particular origin to a particular destination. The Fratar growth factor method is ideally suited for this task.

The basic premise of the Fratar method is that the distribution of future shipments from a zone is proportional to the base year distribution modified by the growth factors of the zones under consideration. This method, as employed by the "PLANPAC/BACKPAC" Urban Transportation Computer Program Package,* applies the origin and destination growth factor to each cell of the O-D matrix in such a way that the future origin total (row sum) is preserved. Actual destination totals (column sums) may not agree with those desired, but an iterative procedure designed to achieve a specified degree of accuracy in the destination totals is included. The mathematical representation of this technique is as follows:

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*Computer Programs for Urban Transportation Planning, PLANPAC/BACKPAC General Information, April, 1977, U.S. Department of Transportation, Federal Highway Administration.

$$\hat{Q}^{gt}_{ij(k+1)} = Q^{g(t-1)}_{ijk} F_{jk} F_{ik}$$

where

$$F_{jk} = \frac{\hat{D}^{gt}_{j}}{\sum_{i=1}^{n} Q^{g(t-1)}_{ijk}}, \quad F_{ik} = \frac{\hat{O}^{gt}_{i}}{\sum_{j=1}^{n} Q^{g(t-1)}_{ijk} F_{jk}}$$

and where

$Q^{g(t-1)}_{ijk}$ = tons shipped between origin i and destination j for iteration k (represents base year tonnage when k = 1).

F_{jk} = destination j (column) growth factor.

F_{ik} = origin i (row) growth factor.

$\hat{D}^{gt}_{j}$, $\hat{O}^{gt}_{i}$ = projected destination (column) and origin (row) totals obtained from the application of shift-share analysis.

In choosing a commodity specific base year O-D matrix upon which to apply the Fratar growth factor method, it was felt that the most recent O-D matrix (1976) would be most appropriate because its entries would best reflect the shifts in O-D patterns that were occurring over time.* However, given that O-D flows for certain years could represent anomalous behavior and not merely the continuation of some trend, it was decided that the 1976 O-D matrices should be inspected before their use as the base year.

This inspection did not show any extreme shifts in the 1976 O-D matrices relative to the previous years except for Commodity Group 6, where BEA 64 showed a sharp drop in shipments from almost 16 percent

*The base year matrix is used only to provide a pattern of shipments.

of all of commodity group 6 in 1975 to less than 3 percent in 1976. BEA 52 showed a fairly sharp drop in receptions from almost 33 percent to less than 24 percent.

Also, the 1976 total tonnage for Commodity Group 5 seemed high relative to the previous years totals, and it was decided that the 1975 O-D matrix was more appropriate, especially in light of the projections for Commodity Group 5 (see Table 63 , Section 3.2 for actual tonnages). Therefore, the 1975 O-D matrix was used as the base year for Commodity Groups 5 and 6, and 1976 was used as the base year for all other commodity groups.

2.4.3 Assignments of Future O-D Movements to Lock and Dam Projects

After developing the 1980, 1985 and 1990 O-D matrix for each commodity group, the remaining task involves taking these O-D flows and assigning the corresponding tonnages to the navigation projects along the river routes which would have to be traversed in going from an origination to a destination. This task falls under the general category of traffic assignment which may be broadly defined as the process of allocating a given set of trip interchanges to a specific transportation system.

The traffic assignment program included in the PLANPAC/BACKPAC computer program package previously mentioned, although usually employed in modeling an urban transportation system, was easily adapted to our purposes. The river system under study can be thought of as a very simple road network, where PE's take the place of intersection's ("nodes" in traffic assignment) and the navigation projects take the place of the roads connecting intersections ("links" in traffic assignment). Once the river network has been described to the computer, i.e., the location of all the PE's and navigation projects in relation to each other and the distances involved, the computer constructs a minimum path tree for all O-D pairs. In the case of the Ohio River System all paths involving O-D pairs are unique except for the section where the Barkley Canal provides an alternate path for traffic involved with the Tennessee or Cumberland and the Ohio Rivers. In that case minimum distance was the criterion

used for choosing the route.* Finally, each commodity specific O-D matrix is input, the tonnage involving each O-D pair is assigned to the navigation projects that would have to be traversed, and the assigned tonnage for each project by commodity group and direction is obtained.

The results of the assignment routine along with graphs for each navigation project depicting historical and projected tonnages in aggregate, appear in Section 3.3.

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*This criterion may constitute a departure from the realities of the situation in that other parameters may have equal or greater weight in the choice of an optimum route. The effect on traffic assignment may be some inaccuracy in the allocation of the traffic among the navigation projects in the area - Kentucky L&D (Tennessee River), Barkley L&D (Cumberland River), and the Barkley Canal. However, CONSAD feels that the combined projected total tonnage for these three projects is accurate. The reader should be aware of this potential discrepancy when examining the projections for these projects.

3.0 RESULTS

This section of the report presents the results obtained by the implementation of the analytic techniques described in Section 2 (Analysis) of this report.

3.1 Regression Relationships Obtained

3.1.1 System Level

The equations and associated statistics presented in the tables of this section represent the results of the regression procedures described in Section 2.3.1 of this report.

After the data was aggregated to the system level, it was noticed that commodity group three, crude petroleum, experienced a ten-fold decrease in tonnage between 1972 and 1974. This severe decrease corresponded to the opening of a pipeline between Owensboro and Catlettsburg, Kentucky. In order to ascertain the future picture of crude petroleum barging, an official of the Pipeline Division of the Ashland Oil Company was contacted and interviewed. The Ashland Oil Company is the major shipper of crude petroleum in the ORB area.

We were informed that within three years, all barging of crude petroleum on the rivers of the ORB would cease.* However, until such a time when a new pipeline could be constructed, or the capacity of an existing one increased, barging of crude petroleum from the Gulf coast up the Mississippi and eventually to Owensboro would continue at the approximate rate of 35,000 barrels/day. Given that a barrel of oil weighs about 300 lbs., the annual tonnage of crude petroleum would equal slightly less than two million tons. Therefore, although no further projections of crude

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*The future intentions of other shippers will be ascertained during the other projection studies planned by the Corps for the ORB.

petroleum shipments were undertaken, the 1980 upstream tonnages for all lock and dam projects on the Ohio River between Cairo and Owensboro reflect this estimated crude petroleum tonnage.

Table 7 : Regression Results: System Level - Commodity Group 1 - Coal and Coke
1975 Tonnage* = 98,236

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Linear: Y = 8530712 + 70140 GNP	.91526	367.24	6,318	GNP/367.24
Geometric: LnY = 13.01285 + .74225 Ln (GNP)	.81463	149.42	.16332	GNP/149.42
Linear: Y = .17820 XN05 - 32,218,016	.93570	174.623	5,646	XN05/174.623
Geometric: LnY = - 37.80132 + 4.08659 Ln (XN05) - 3.80762 Ln (XN04) + .28984 Ln (XN07)	.98274	189.764	.05601	XN05/38.581 XN04/16.647 XN07/4.195
Linear: Y = - 31,672,927 + 102,596 XB11 - 28,783 XB14	.96392	173.749	4,074	XB11/97,183 XB14/2.498
Geometric: LnY = .0443 + 1.6496 Ln (XB11) - 0.3777 Ln (XB14)	.98168	294.771	.05501	XB11/105.002 XB14/2.767

*Thousands of tons

Table 8 : Regression Results: System Level - Commodity Group 2 - Petroleum Fuels
1975 Tonnage* = 18,846

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Linear: $Y = -305,935 + 15,204\ GNP$	.94726	610.696	1,062	GNP/610.696
Parabolic: $Y = -2,071,004 + 20694\ GNP - 3.64321\ (GNP)^2$	.95169	325.015	1,032	GNP/41.443 $(GNP)^2$/3.022
Linear: $Y = .57211\ XN15 - 10,403,156$	.94525	207.167	1,110	XN15/207.167
Parabolic: $LnY = -21.65735 + 2.16845\ Ln\ (XN15)$	.95369	247.108	.11451	XN15/247.108
Linear: $Y = -58,465,846 + 5800\ (XB15) + 3440\ (XB02)$	.96243	140.904	960	XB15/8.822 XB02/5.799
Parabolic: $Y = -33,054,134 + 5392\ (XB15) + 0.1\ (XB02)^2$	.96386	146.692	942	XB15/7.204 XB02/6.463

*Thousands of tons

Table 9 : Regression Results: System Levels - Commodity Group 4 - Aggregates
1974 Tonnage* = 22,098

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Linear: $Y = 3163569 + 16385\ GNP$	.87348	234.731	1,846	GNP/234.731
Exponential: $LnY = 15.63877 + .0014\ GNP$	.78289	122.605	.17726	GNP/122.605
Linear: $Y = .63418\ XN17 - 4,869,195$	.84165	63.779	2,119	XN17/63.779
Exponential: $LnY = -14.39012 - 2.05881\ Ln\ (XN04) + 2.75465\ Ln\ (XN17)$	.93220	75.61834	.10614	XN04/4.878 XN17/17.193
Linear: $Y = -4,284,360 + 8750\ XB17$	.88658	93.803	1,793	XB17/93.803
Exponential: $LnY = 7.16848 + 1.21284\ Ln\ (XB17)$	.92397	145.828	.10761	XB17/145.828

*Thousands of tons

Table 10 : Regression Results: System Level - Commodity Group 5 - Grains
1975 Tonnage* = 4,097

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Linear: Y = - 1716337 + 4430 GNP	.88164	253.268	480	GNP/253.268
Geometric: LnY = - 4.35944 + 2.74916 Ln (GNP)	.79166	129.194	.65052	GNP/129.194
Linear: Y = - 9098492 + .87200 XN10	.86470	76.692	527	XN10/76.692
Geometric: Other curves inappropriate for projection purposes				
Linear: Y = - 16,300 + 773 (XB16) - 2690 (XB06)	.88187	41.059	514	XB16/19.147 XB06/12.540
Parabolic: Y = - 1,210,604 + 735 (XB16) - 1 $(XB06)^2$	.89085	44.890	494	XB16/17.839 XB06/14.477

*Thousands of tons

Table 11 : Regression Results: System Level - Commodity Group 6 - Chemicals and Chemical Fertilizers 1973 Tonnage* = 10,591

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Linear: Y = - 5,034,763 + 12717 GNP	.91071	346.79	1,179	GNP/346.79
Geometric: LnY = - .84574 + 2.39558 Ln (GNP)	.91399	361.298	.33897	GNP/361.298
Linear: Y = - 12,427,173 + .03232 XN05	.93152	163.232	1,059	XN05/163.232
Geometric: LnY = - 44.54767 + 3.71028 Ln (XN11)	.98243	670.962	.15717	XN11/670.962
Linear: Y = - 10,499,211 + 1,460 (XB09) - 2087 (XB06)	.92313	66.046	1,172	XB09/60.394 XB06/7.307
Geometric: LnY = - 39.3341 + 4.1286 Ln (XB09) - 0.9400 (XB06)	.98646	400.562	.14413	XB09/326.648 XB06/14.241

*Thousands of tons

Table 12 : Regression Results: System Level - Commodity Group 7 - Ores and Minerals
1975 Tonnage* = 3,446

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Linear: Y = - 1365944 + 4374 GNP	.90268	315.351	425	GNP/315.351
Geometric: LnY = .46315 + 2.08659 Ln (GNP)	.89418	287.307	.33109	GNP/287.307
Linear: Y = - 3,304,872 + .00995 XN05	.73924	34.020	714	XN05/34.020
Geometric: LnY = - 49.84333 - 1.29460 Ln (XN07) + 5.16566 Ln (XN13)	.89489	46.827	.35356	XN07/3.72 XN13/83.282
Linear: Y = - 6,213,546 + 5664 (XB14) + 1494 (XB13)	.83033	26.915	602	XB14/7.678 XB13/3.410
Geometric: LnY = - 42.9451 + 4.1445 Ln (XB09) - 0.7407 Ln (XB07)	.92786	70.740	.29291	XB09/141.469 XB07/6.114

*Thousands of tons

Table 13: Regression Results: System Level - Commodity Group 8 - Iron Ore and Iron and Steel 1974 Tonnage* = 5,125

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Linear: $Y = 1,318,177 + 3212$ GNP	.53070	38.448	894	GNP/38.448
Exponential: $LnY = 14.30158 + .00101$ GNP	.53875	39.712	.27785	GNP/39.712
Linear: $Y = -721,544 + .00850$ XN05	.58820	17.140	859	XN05/17.140
Geometric: $LnY = -9.47670 + 1.22392$ Ln (XN05)	.63467	20.847	.25367	XN05/20.847
Exponential: $LnY = 13.23541 + .15341$ XN13A**	.61434	19.115	.26063	XN13A**/19.115
Linear: $Y = -273,520 + 1775$ (XB17)	.57656	16.339	871	XB17/16.339
Geometric: $LnY = -11.80066 + 1.09924$ Ln (XB13) $+ 0.79178$ Ln (XB14)	.66264	10.803	.25461	XB13/1.820 XB14/1.093

*Thousands of tons
**Where XN13A = XN13/1,000,000

Table 14 : Regression Results: System Level - Commodity Group 9 - All Other
1975 Tonnage* = 10,316

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Linear: $Y = -3493245 + 10561\ GNP$	.89479	289.176	1,072	GNP/289.176
Geometric: $LnY = 4.1317 + 1.65715\ Ln\ (GNP)$	.72216	88.37	.47412	GNP/88.37
Linear: $Y = -11{,}492{,}375 + .18122\ XN16$	.92432	146.561	933	XN16/146.561
Geometric: $LnY = -55.30756 + 3.74169\ Ln\ (XN09)$	.93827	182.407	.22925	XN09/182.407
Linear: $Y = -11{,}513{,}842 + 1361\ (XB09)$	.93964	186.807	833	XB09/186.807
Parabolic: $Y = -15{,}716{,}172 + 2231\ (XB09) - 0.04\ (XB09)^2$	.94535	95.138	828	XB09/7.448 $(XB09)^2$/1.149
Geometric: $LnY = -38.79900 + 7.37237\ Ln\ (XB09) - 3.80329\ Ln\ (XB05)$	.96179	138.433	.18840	XB09/26.625 XB05/7.114

*Thousands of tons

3.1.2 Individual River Level

The equations presented in the tables of this section represent the results of the procedures described in Section 2.3.2 of this report. Table 15 summarizes the commodity groups studied for each river by direction. Tables 16-36 present the actual equations and associated statistics obtained for each river by direction and commodity group.

Table 15: COMMODITY GROUPS ANALYZED BY RIVER AND DIRECTION

RIVER	DIRECTION	COMMODITY GROUPS ANALYZED
Ohio	Up	1, 2, 4 - 9
Ohio	Down	1, 2, 4 - 9
Ohio	Other	1, 2, 4 - 9
Monongahela	Up	1, 2, 4, 6 - 9
Monongahela	Down	1, 2, 4, 6 - 9
Allegheny	Up	1, 2, 4, 6 - 9
Allegheny	Down	1, 2, 4, 8, 9
Kanawha	Up	1, 2, 4, 6 - 9
Kanawha	Down	1, 2, 6 - 9
Kentucky	Up	4
Green	Down	1, 5
Cumberland	Up	1, 2, 6 - 9
Cumberland	Down	1, 2, 5 - 9
Tennessee	Up	1, 2, 4 - 9
Tennessee	Down	1, 2, 4 - 9

Table 16: Regression Results: Individual Rivers - Ohio River - Upbound

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = 13,314,337 + 17,521 XB11	.92121	140.309	1,273	XB11/140.309
Petroleum Fuels: Y = 39,112,293 + 2,710 XB02	.93594	175.336	435	XB02/175.336
Aggregates: Y = 2,035,814 + 2,269 XB17	.81921	54.377	611	XB17/54.377
Grains: Y = 3,554556 - 2,606 XB06	.53152	13.615	608	XB06/13.615
Chemicals and Chemical Fertilizers: Y = 3,987,527 + 439 XB09	.91745	133.359	318	XB09/133.359
Ores and Minerals: Y = 2,915,332 + 4,492 XB14	.76747	39.607	351	XB14/39.607
Iron Ore and Iron and Steel: Y = 455,624 + 294 XB17 + 287 XB08	.82857	26.583	99	XB17/32.876 XB08/8.904
All Other: Y = 2,635,552 + 307 XB09	.77210	40.654	403	XB09/40.654

Table 17 : Regression Results: Individual Rivers - Ohio River - Downbound

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = 16,592,191 + 17,476 XB11 + 6,449 XB08	.90417	51.985	1,748	XB11/70.609 XB08/14.608
Petroleum Fuels: Y = -3,236,420 + 1,901 XB15	.89068	97.765	299	XB15/97.765
Aggregates: Y = -5,075,5[illegible] + 4,476 XB13	.75069	36.132	925	XB13/36,132
Grains: Y = =1,025,333 + 200 XB16	.61752	19,374	168	XB16/19.374
Chemicals and Chemical Fertilizers: Y = 1,662,348 - 1,598 XB06 + 52 XB09	.85344	32,027	212	XB06 /23.421 XB09/2.352
Ores and Minerals: Y = -169,265 + 217 XB07	.57108	15.977	71	XB07/15.977
Iron Ore and Iron and Steel: Y = 287,293 + 265 XB17	.17226	2.497	333	XB17/2.497
All Other: Y = -4,460,620 + 508 XB09	.75862	37.714	692	XB09/37.714

Table 18 : Regression Results: Individual Rivers - Ohio River - Other

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = -24,648,274 + 21,259 XB13	.85886	73.025	3,090	XB13/73.025
Petroleum Fuels: Y = -6,834,213 + 4,786 XB15	.94481	205.419	519	XB15/205.419
Aggregates: Y = -2,983,619 + 2,827 XB17	.93023	159.995	444	XB17/159.995
Grains: Y = -2,042,506 + 466 XB16	.61140	18.880	397	XB16/18.880
Chemicals and Chemical Fertilizers: Y = -8,093,072 + 9,228 XB11	.90530	114.710	741	XB11/114.710
Ores and Minerals: Y = -3,069,470 + 1,725 XB13	.71303	29.817	392	XB13/29.817
Iron Ore and Iron and Steel: Y = -1,624,477 + 1,433 XB13	.53215	13.649	482	XB13/13.649
All Other: Y = -4,223,761 + 1,081 XB16	.89090	97.992	404	XB16/97.992

Table 19 : Regression Results: Individual Rivers - Monongahela River - Upbound

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = 5,881,643 + 3,768 XB13	.59063	17.313	1,125	XB13/17.313
Petroleum Fuels: Y = 1,149,509 + 8,706 XB12 + 467 XB15	.83817	28.487	226	XB12/6.006 XB15/2.888
Aggregates: Y = 2,515,302 - 370 XB17	.31130	5.424	316	XB17/5.424
Chemicals and Chemical Fertilizers: Y = 450,377 - 344 XB06	.54566	14,412	78	XB06/14.412
Ores and Minerals: Y = 619,531 + 2,308 XB14 - 420 XB13	.70111	12.901	154	XB14/19.405 XB13/4.110
Iron Ore and Iron and Steel: Y = -53,084 - 297 XB07 + 1,508 XB14	.71665	13.911	160	XB14/21.324 XB07/5.875
All Other: Y = -257,937 - 40 XB05 + 160 XB09	.40748	3.782	116	XB09/3.288 XB05/2.150

Table 20 : Regression Results: Individual Rivers - Monongahela River - Downbound

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = 11,303,758 + 5,918 XB13	.40830	8.280	2,555	XB13/8.280
Petroleum Fuels: Y = 3,346,049 + 262 XB15 - 247 XB02	.65822	10.592	41	XB02/16.448 XB15/9.980
Aggregates: Y = 374,034 + 283 XB17	.66154	23.454	116	XB17/25.454
Chemicals and Chemical Fertilizers: Y = 231,914 + 121 XB06	.09769	1.299	92	XB06/1.299
Ores and Minerals: Y = 146,181 + 117 XB07	.62187	18.091	52	XB07/18.091
Iron Ore and Iron and Steel: Y = 485,226 + 383 XB08	.09202	1.216	369	XB08/1.216
All Other: Y = -6,680 - 9 XB03 + 45 XB09	.11986	.749	73	XB09/1.295 XB03/1.016

Table 21: Regression Results: Individual Rivers - Allegheny River - Upbound

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = 1,180,311 + 1,313 XB15 - 714 XB13	.81255	23.841	197	XB15/28.169 XB13/5.309
Petroleum Fuels: Y = -1,076,423 + 79 XB02	.32826	5.864	70	XB02/5.864
Aggregates: Y = 344,233 + 770 XB14 - 333 XB13	.46294	4.741	80	XB13/8.973 XB14/7.990
Chemicals and Chemical Fertilizers: Y = -45,939 + 84 XB11	.58952	15.798	17	XB11/15.798
Ores and Minerals: Y = -179,356 + 22 XB09	.52091	13.048	50	XB09/13.048
Iron Ore and Iron and Steel: Y = 271,305 + 546 XB07 - 785 XB08	.52986	6.199	65	XB08/10.366 XB07/7.630
All Other: Y = 495,430 + 60 XB09	.75263	36.510	82	XB09/36.510

Table 22: Regression Results: Individual Rivers - Allegheny River - Downbound

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = 4,356,238 + 975 XB13 - 3,818 XB14 - 1,720 XB08	.70838	8.097	395	XB08/19.603 XB14/7.567 XB13/3.103
Petroleum Fuels: Y = 622,054 + 458 XB12 - 50 XB02	.44983	4.497	15	XB12/8.966 XB02/5.107
Aggregates: Y = 162,638 + 396 XB17	.43156	9.111	261	XB17/9.111
Iron Ore and Iron and Steel: Y = -564 + 21 XB14	.06204	.794	11	XB14/.794
All Other: Y = -26,794 + 4 XB09	.36021	6.756	13	XB09/6.756

Table 23: Regression Results: Individual Rivers - Kanawha River - Upbound

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = -945,127 + 713 XB13	.29487	5.018	395	XB13/5.018
Petroleum Fuels: Y = -871,880 + 445 XB15 + 2,036 XB12	.94193	89.209	68	XB15/28.956 XB12/3.631
Aggregates: Y = -805,512 + 673 XB17	.70270	28.363	251	XB17/28.363
Chemicals and Chemical Fertilizers: Y = 513,721 + 312 XB09 - 2,621 XB06	.87111	37.171	515	XB09/14.280 XB06/10.668
Ores and Minerals: Y = -126,056 + 381 XB14	.17206	2.494	119	XB14/2.494
Iron Ore and Iron and Steel: Y = -6,159 - 12 XB07 + 14 XB13	.34260	2.866	8	XB13/3.980 XB07/3.115
All Other: Y = -298,615 + 232 XB09 - 64 XB05	.71396	13.728	71	XB09/18.481 XB05/14.252

Table 24: Regression Results: Individual Rivers - Kanawha River - Downbound

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = 4522088 - 2757 XB08 + 4129 XB14	.76911	18.321	600	XB08/23.714 XB14/11.435
Petroleum Fuels: Y = 2498048 + 1701 XB12 - 164 XB02	.92348	66.380	20	XB02/119.916 XB12/41.473
Chemicals and Chemical Fertilizers: Y = -56774 + 228 XB09 - 363 XB06 - 1687 XB11	.82199	15.392	104	XB09/4.417 XB06/3.815 XB11/2.304
Ores and Minerals: Y = -42828 + 27 XB13	.42305	8.799	11	XB13/8.799
Iron Ore and Iron and Steel: Y = 10402 + 52 XB14 - 25 XB08	.22417	1.589	21	XB08/1.607 XB14/1.434
All Other: Y = 62912 - 4 XB09	.49032	1.544	10	XB09/11.544

Table 25: Regression Results: Individual Rivers - Kentucky River - Upbound

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Aggregates: Y = -551947 + 352 XB17	86195	74.928	81	XB17/74.928

Table 26: Regression Results: Individual Rivers - Green River - Downbound

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = -20876415 + 7142 XB08 +20685 XB11	96279	129.374	1,241	XB11/180.967 XB08/32.784

Table 27: Regression Results: Individual Rivers - Cumberland River - Upbound

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = -5282421 + 6729 XB08	.86769	45.905	826	XB08/45.905
Petroleum Fuels: Y = -4991496 + 456 XB02 - 11464 XB12	.32008	2.589	376	XB12/5.078 XB02/2.508
Chemicals and Chemical Fertilizers: Y = -378609 + 42 XB09	.74985	35.971	59	XB09/35.971
Ores and Minerals: Y = 2918795 + 1048 XB07 + 2340 XB14	.75074	16.565	307	XB07/19.959 XB14/14.048
Iron Ore and Iron and Steel: Y = -176891 + 87 XB17 + 61 XB08	.78226	19.759	32	XB17/28.271 XB08/3.873
All Other: Y = -585601 + 66 XB09	.86672	78.038	63	XB09/78.038

Table 28 : Regression Results: Individual Rivers - Cumberland River - Downbound

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = -2297 + 35 XB13	.01982	.182	89	XB13/.182
Petroleum Fuels: Y = -4947 + 119 XB12	.13193	1.368	11	XB12/1.368
Chemicals and Chemical Fertilizers: Y = -24821 + 5 XB09	.41502	7.095	14	XB09/7.095
Ores and Minerals: Y = -1996034 + 392 XB07 + 765 XB13	.71695	6.332	244	XB13/7.686 XB07/2.247
Iron Ore and Iron and Steel: Y = -21013 - 64 XB14 + 46 XB13	.39865	3.646	14	XB13/6.190 XB14/1.862
All Other: Y = -1312478 + 87 XB03 - 191 XB09	.83481	27.795	218	XB03/10.449 XB09/2.703

Table 29: Regression Results: Individual Rivers - Tennessee River - Upbound

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = -8639807 + 10827 XB11	.90114	109.379	891	XB11/109.379
Petroleum Fuels: Y = -2358444 + 1306 XB15	.57283	16.092	506	XB15/16.092
Aggregates: Y = -2071375 + 1729 XB17	.86982	80.183	383	XB17/80.183
Grains: Y = 3720634 - 2645 XB06	.49519	11.771	663	XB06/11.771
Chemicals and Chemical Fertilizers: Y = -2398391 + 251 XB09	.74784	35.590	352	XB09/35.590
Ores and Minerals: Y = -1058469 + 161 XB09 - 291 XB07	.81870	24.836	184	XB09/49.672 XB07/3.956
Iron Ore and Iron and Steel: Y = -572203 + 243 XB17 + 221 XB08	.80822	23.178	86	XB17/29.628 XB08/7.033
All Other: Y = -1834289 + 435 XB16	.79836	47.511	234	XB16/47.511

Table 30 : Regression Results: Individual Rivers - Tennessee River - Downbound

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = -7095846 + 2274 XB15 + 3378 XB14	.93945	85.330	383	XB15/26.264 XB14/5.794
Petroleum Fuels: Y = -66173 + 823 XB12	.82671	57.248	13	XB12/57.248
Aggregates: Y = 489246 + 759 XB14	.05174	.655	461	XB14/.655
Grains: Y = -98368 + 14XB16 + 35 XB06	.81705	24.564	6	XB16/48.987 XB06/16.214
Chemicals and Chemical Fertilizers: Y = -738208 + 83 XB09	.89199	99.101	69	XB09/99.101
Ores and Minerals: Y = 32401 - 120 XB13 + 23 XB09	.52798	6.152	17	XB09/7.654 XB13/4.642
Iron Ore and Iron and Steel: Y = -257925 + 62 XB17 + 95 XB13	.88223	41.200	26	XB17/3.220 XB13/2.995
All Other: Y = -2306428 + 75 XB03	.45155	9.880	857	XB03/9.880

Table 31 : Regression Results: Individual Rivers vs. Local Variables Monongahela River - Upbound

XBEA66

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = -8075050 + 37214 XBEA14	.72869	32.2305	916	XBEA14/32.231
Petroleum Fuels: Y = 13731992 + 4931 XBEA15 -4420 XBEA02	.80446	22.6277	248	XBEA15/44.998 XBEA02/5.934
Aggregates: Y = 3113463 - 901 XBEA12	.21435	3.2740	337	XBEA12/3.274
Chemicals and Chemical Fertilizers: Y = -324991 + 123 XBEA09	.21514	3.2893	102	XBEA09/3.289
Ores and Minerals: Y = -369322 + 2028 XBEA09 - 4024 XBEA13	.68015	11.6955	159	XBEA09/20.722 XBEA13/16.305
Iron Ore and Iron and Steel: Y = 344331 + = 1561 XBEA17 - 1096 XBEA07	.65031	10.2281	178	XBEA17/14.029 XBEA07/6.509
All Other: Y = -12744556 + 5618 XBEA09	.82097	55.0295	1,147	XBEA09/55.030

Table 32: Regression Results: Individual Rivers vs. Local Variables
Monongahela River - Downbound

XBEA66

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = 8019051 + 57891 XBEA14	.49421	11.7250	2,362	XBEA14/11.725
Petroleum Fuels: Y = 3135595 - 823 XBEA02	.26078	4.2333	57	XBEA02/4.233
Aggregates: Y = -487054 + 1303 XBEA17	.65293	22.5747	117	XBEA17/22.575
Chemicals and Chemical Fertilizers: Insufficient Data				
Ores and Minerals: Y = -379609 + 561 XBEA07 + 691 XBEA13 - 245 XBEA09	.70104	7.0346	51	XBEA07/17.774 XBEA13/4.001 XBEA09/2.517
Iron Ore and Iron and Steel: Y = 509865 + 973 XBEA07	.09069	1.1968	369	XBEA07/1.197
All Other: Y = 17846 + 9 XBEA05	.03313	.4112	74	XBEA05/.411

Table 33: Regression Results: Individual Rivers vs. Local Variables
Allegheny River - Upbound

XBEA66

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = -1692077 + 11676 XBEA11 + 1287 XBEA07	.66843	11.0877	261	XBEA11/15.812 XBEA07/3.848
Petroleum Fuels: Y = -63347 + 343 XBEA15	.16882	2.4372	77	XBEA15/2.437
Aggregates: Y = 660989 - 518 XBEA13 + 707 XBEA17	.35625	3.0437	88	XBEA13/6.004 XBEA17/4.465
Chemicals and Chemical Fertilizers: Y = -166589 + 1000 XBEA11 + 977 XBEA06	.74298	14.4536	14	XBEA11/28.375 XBEA06/9.423
Ores and Minerals: Y = -261463 + 2179 XBEA14 - 714 XBEA12 + 239 XBEA09	.74667	9.8249	40	XBEA14/5.011 XBEA12/7.074 XBEA09/4.003
Iron Ore and Iron and Steel: Y = -349333 + 2633 XBEA14 - 460 XBEA17	.52079	5.9772	65	XBEA14/8.756 XBEA17/2.506
All Other: Y = -1019477 + 349 XBEA09	.84974	67.8599	64	XBEA09/67.860

Table 34: Regression Results: Individual Rivers vs. Local Variables
Allegheny River - Downbound

XBEA66

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = 4168793 - 3585 XBEA08 - 7998 XBEA11	.53617	6.358	476	XBEA08/9.022 XBEA11/2.244
Petroleum Fuels: Y = 5156 + 634 XBEA12	.27854	4.633	16	XBEA12/4.633
Aggregates: Y = 520442 + 3844 XBEA17 - 18138 XBEA14 + 2264 XBEA13	.68544	7.263	212	XBEA17/16.244 XBEA14/10.127 XBEA13/5.067
Iron Ore and Iron and Steel: Y = 2399 + 25 XBEA17	.06699	.862	11	XBEA17/.862
All Other: Y = -61071 + 23 XBEA09	.39918	7.973	12	XBEA09/7.973

Table 35: Regression Results: Individual Rivers vs. Local Variables
Kanawha River - Upbound

XBEA52

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = 4876989 - 516838 XBEA14	.50346	1.014	451	XBEA14/1.014
Petroleum Fuels: Y = -628307 + 3562 XBEA15 + 9641 XBEA12	.93959	85.549	69	XBEA15/25.215 XBEA12/13.166
Aggregates: Y = -403125 + 6474 XBEA17	.86894	6.630	226	XBEA17/6.630
Chemicals and Chemical Fertilizers: Y = 3405195 - 65762 XBEA06	.81352	52.350	593	XBEA06/52.350
Ores and Minerals: Y = -32071 + 1272 XBEA13	.15217	.179	163	XBEA13/.179
Iron Ore and Iron and Steel: Y = 86392 - 9171 XBEA14	.35048	.5395	11	XBEA14/.540
All Other: Y = -496347 + 2375 XBEA09 - 2039 XBEA16	.83812	28.4766	53	XBEA09/50.104 XBEA16/20.211

Table 36: Regression Results: Individual Rivers vs. Local Variables
Kanawha River - Downbound

XBEA 52

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = 18364599 - 1613236 XBEA 14	.76059	3.1769	794	XBEA14/3.177
Petroleum Fuels: Y = -1403813 + 1091 XBEA 02	.82712	57.4118	28	XBEA02/57.412
Aggregates: Not Enough Cases				
Chemicals and Chemical Fertilizers: Y = 1994390 - 14470 XBEA 06 - 7260 XBEA11	.83673	28.1856	95	XBEA06/47.374 XBEA11/8.218
Ores and Minerals: Y = 179159 - 19635 XBEA 14	.70386	2.3767	11	XBEA14/2.377
Iron Ore and Iron and Steel: Y = 315777 - 35318 XBEA 14	.97854	45.5937	4	XBEA14/45.594
All Other: Y = 85361 - 116 XBEA 09	.52207	13.1083	9	XBEA09/13.108

3.1.3 Key Lock and Dam Project Level

The equations presented in the tables of this section represent the results of the procedures described in Section 2.3.3 of this report. Table 37 lists the key lock and dam projects chosen for analysis, the river on which each is located, and the commodity groups chosen for study. Tables 38-50 present the actual equations and associated statistics obtained for each lock and dam project.

Table 37: COMMODITY GROUPS ANALYZED FOR KEY LOCK AND DAMS

LOCK AND DAM	RIVER	COMMODITY GROUPS ANALYZED
Montgomery	Ohio	1, 2, 4, 8
Gallipolis	Ohio	1, 2, 6, 8
#52	Ohio	1, 2, 6, 9
#2	Allegheny	1, 4, 8, 9
#7	Monongahela	1, 2, 4
Winfield	Kanawha	1, 4, 6
#1	Kentucky	4
#1	Green	1
Cheatham	Cumberland	2, 4, 9
Kentucky	Tennessee	1, 2, 4, 9

Table 38 : Regression Results: Lock and Dam Projects - Kentucky Lock and Dam - Tennessee River

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = -9,785,116 + 8263 XB15 - 8507 XB14	.90507	47.670	950	XB15/52.037 XB14/5.513
Petroleum Fuels: Y = 775.6789 XB02 - 11,006,698	.40645	7.533	577	XB02/7.533
Aggregates: Y = -2,083,856 + 1391 XB17	.70386	26.145	519	XB17/26.145
All Other: Y = 4,981,450 + 3555 XB16 -1,088 XB09	.85265	28.933	581	XB16/18.709 XB09/8.965

Table 39 : Regression Results: Lock and Dam Projects - Cheatham Lock and Dam - Cumberland River

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Petroleum Fuels: $Y = -6711.3551\ XB12 + 2{,}093{,}679$	.45090	5.748	264	XB12/5.748
Aggregates: $Y = -234{,}488 + 610\ XB13$	.65480	13.278	163	XB13/13.278
All Other: $Y = -850{,}031 + 483\ XB16 - 134\ XB09$	.83608	15.302	103	XB16/7.299 XB09/2.847

Table 40 : Regression Results: Lock and Dam Projects - Lock and Dam #1 - Green River

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: $Y = 16045.1996\ XB11 + 5500.0131\ XB08 - 12,143,113$	.95282	100.972	1,088	XB11/141.650 XB08/25.289

Table 41 : Regression Results: Lock and Dam Projects - Lock and Dam #1 - Kentucky River

Equation	R^2	Equation *F-Test* Value	*Standard* Error	*Variable/* F-Test
Aggregates: Y = -142,723 + 464 XB17 - 636 XB14	.82776	24.029	90	XB17/17.540 XB14/2.024

Table 42 : Regression Results: Lock and Dam Projects - Winfield Lock and Dam - Kanawha River

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = 4,795,754 - 1,134 XB08 + 1343 XB14	.58373	4.207	378	XB08/6.226 XB14/1.876
Aggregates: Y = 174,493 + 503 XB17	.57981	9.659	252	XB17/9.659
Chemicals and Chemical Fertilizers: Y = -2134.0377 XB06 - 1915.8979 XB11 + 7,875,020	.68287	6.460	294	XB06/12.037 XB11/9.701

Table 43 : Regression Results: Lock and Dam Projects - Lock and Dam #7 - Monongahela River

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = -9,131,841 + 6382 XB13	.64917	22.205	1,682	XB13/22.205
Petroleum Fuels: Y = -1,316,776 + 97 XB02	.55714	15.096	53	XB02/15.096
Aggregates: Y = -387,407 + 286 XB17	.67381	24.788	114	XB17/24.788

Table 44 : Regression Results: Lock and Dam Projects - Lock and Dam #2 - Allegheny River

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = 2285.7656 XB11 - 1025.79 XB13 + 1,577,637	.42246	4.023	298	XB11/3.978 XB13/1.670
Aggregates: Y = 324.7459 XB17 - 791.7013 XB14 + 366950	.41743	3.941	120	XB17/5.282 XB14/1.926
Iron Ore and Iron and Steel: Y = -838.8448 XB08 + 584.7135 XB07 + 303,842	.55054	6.737	66	XB08/11.348 XB07/8.400
All Other: Y = -651.843 + 150 XB16	.94449	204.184	39	XB16/204.184

Table 45 : Regression Results: Lock and Dam Projects - Gallipolis Lock and Dam - Ohio River

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = -8,732,706 + 12089 XB11 + 3601 XB08	.82174	25.355	1,660	XB11/37.427 XB08/5.045
Petroleum Fuels: Y = -31,534,430 + 2241 XB02	.80748	50.331	672	XB02/50.331
Chemicals and Chemical Fertilizers: Y = 547,767 + 275 XB09 - 1479 XB06	.62851	8.459	767	XB09/4.605 XB06/1.414
Iron Ore and Iron and Steel: Y = 780.6924 XB17 + 895,443	.32217	5.703	649	XB17/5.703

Table 46 : Regression Results: Lock and Dam Projects - Montgomery Lock and Dam - Ohio River

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = -2664 XB08 + 7419 XB13 - 10563 XB11 + 4,485,152	.63469	5.791	1,013	XB08/6.210 XB13/6.314 XB11/5.960
Petroleum Fuels: Y = 775.3513 XB02 - 9,827,789	.46727	10.526	508	XB02/10.526
Aggregates: Y = 1639.6374 XB14 + 733,481	.27565	4.186	379	XB14/4.186
Iron Ore and Iron and Steel: Y = 540.4686 XB17 + 776,580	.21030	3.196	600	XB17/3.196

Table 47: Regression Results: Lock and Dam Projects - Lock and Dam #52 - Ohio River

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: $Y = -16,331,561 + 20,397\ XB11$	.94109	191.695	1,267	XB11/191.695
Petroleum Fuels: $Y = -32,203,427 + 2517\ XB02$	.68505	26.101	1,047	XB02/26.101
Chemicals and Chemical Fertilizers: $Y = -7,583,750 + 9670\ XB11$	.93313	153.497	645	XB11/153.497
All Other: $Y = -8,453,115 + 1089\ XB09$	.83267	59.713	1,178	XB09/59.713

Table 48 : Key Lock and Dams
Lock and Dam #7 - Monongahela River

XBEA66

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = -9217672 + 6760 XBEA13 -8609 XBEA08 + 45282 XBEA11	.80028	13.3568	1,390	XBEA13/3.863 XBEA08/5.490 XBEA11/3.025
Petroleum Fuels: Y = -110052 + 453 XBEA15	.33851	6.1408	65	XBEA15/6.141
Aggregates: Y = -828156 + 744 XBEA17 + 2268 XBEA14	.77893	19.3787	98	XBEA17/2.887 XBEA14/2.863

Table 49: Key Lock and Dams
Winfield Lock and Dam - Kanawha River

BEA52

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Not Enough Cases				
Aggregates: Not Enough Cases				
Chemicals and Chemical Fertilizers: Y = 5863346 - 3957 BEA09	.49646	6.9015	343	BEA09/6.902

Table 50: Key Lock and Dams
Lock and Dam #2 - Allegheny River

BEA66

Equation	R^2	Equation F-Test Value	Standard Error	Variable/ F-Test
Coal and Coke: Y = 397552 + 9445 XBEA11	.42686	8.9371	283	XBEA11/8.937
Aggregates: Y = 1368 XBEA17 - 9819 XBEA14 + 1482 XBEA13 + 153339	.65436	6.3107	96	XBEA17/9.887 XBEA14/14.247 XBEA13/10.434
Iron Ore and Iron and Steel: Y = 1044 XBEA14 - 288 XBEA08 - 28768	.39214	3.5481	76	XBEA14/3.474 XBEA08/2.195
All Other: Y = -999842 + 847 XBEA16	.93593	175.293	42	XBEA16/175.293

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3.1.4 Comparison: System vs. Components

In comparing the regression results obtained using basin level population, income, and earnings as independent variables at the system level versus those obtained at the individual river and key lock and dam levels of analysis, there are several things that the reader must keep in mind. First, in aggregating the river data to create the system data, whatever peculiarities may have been present in each of the individual river data sets would tend to be smoothed out as a result of combining the data on the eight rivers in the ORB. Second, each river flows through an area possessing its own unique industrial and demographic characteristics resulting in river specific commodity mixes as well as the likelihood that these commodities are moving in response to these areal characteristics. Thus, in some cases, it should not be surprising to find subsystem commodity movements correlating poorly with the same variables which produced high correlations at the system level.

Tables 51-58 compare the regression results obtained at the system level versus those obtained for the individual rivers and key lock and dam projects for each commodity group. Except for Commodity Group 8 (Down), a very strong association exists between the Ohio River and the system. This is not at all surprising since the Ohio River has historically carried approximately 75 percent of the system's traffic.

Among the tributaries, the degree of association is not quite as strong, but generally is still significant. However, there are certain exceptions, "weak spots" in the analysis, which require discussion.

For Coal and Coke (Group 1), weak spots occur on the Monongahela (both directions), up the Kanawha, and down the Cumberland, although coal and coke traffic down the Cumberland is relatively light (see Appendix B for river traffic volumes by direction). In all of these cases Earnings in the Manufacture of Primary Metals (XB13) entered the river-level regression equations instead of the variables used at the system level, Earnings in the Manufacture of Chemicals and Allied Products (XB11) and Fabricated Metals (XB14).

For Petroleum Fuels (Group 2) the weak spots occur on the Allegheny and Cumberland Rivers, both directions, although petroleum fuel volume down both of these rivers has been very light. Some preference for Earnings in Petroleum Refining (XB12) was shown over Earnings in Transportation, Communication, and Utilities (XB15), chosen at the system level.

The third major commodity group, Aggregates (Group 4) has weak spots occurring on the Allegheny (both directions), up the Monongahela, and down the Tennessee. Aggregates tonnage moving up the Allegheny dropped quite severly in 1974 and remained low in 1975. Whether or not this represents a permanent drop is a question which can best be answered by the other ORB projection studies being undertaken by the Corps. Earnings in Contract Construction (XB17), used as the independent variable at the system level, entered the equations at the individual river level, except for down the Ohio where Earnings in the Manufacture of Primary Metals (XB13) was entered; up the Allegheny where Earnings in the Manufacture of Primary (XB13) and Fabricated Metals (XB14) were entered; and down the Tennessee where XB14 was again entered.

Grains (Group 5) appear in significant quantities only on the Ohio and Tennessee Rivers. Weak spots exist up the Tennessee and Ohio, although the R^2 and F-test values obtained for these equations were not very different from those obtained for the other grain equations. The variables used at the system level, Earnings in Wholesale and Retail Trade (XB16) and Agriculture (XB06), consistently entered the equations at the individual river level.

For Chemicals and Chemical Fertilizers (Group 6) weak spots occur on the Monongahela and Cumberland Rivers in the downstream direction. However, traffic down the Cumberland for this commodity group has been quite light, reaching a maximum of fifty-three thousand tons in 1973. Except for the Ohio River (other direction) and up the Allegheny, which both correlated best with Earnings in the Manufacture of Chemicals and Allied Products (XB11), the river regression equations utilized the same variables, Earnings in Argiculture (XB06) and Manufacturing (XB09), as the system level equation.

Ores and Minerals (Group 7) has weak spots occurring on the Kanawha (both directions), although traffic volume in the downstream direction is quite light. To a lesser extent, the regression results down the Tennessee, up the Allegheny, and down the Ohio were also weak relative to system level results. Again, however, the traffic volumes are not particularly heavy and variation here is not likely to significantly affect waterway improvement decisions. There was some variation in the variables chosen by the regression package with Earnings in Mining (XB07) and Manufacturing (XB09) carrying about the same load as Earnings in the Manufacture of Primary (XB13) and Fabricated (XB14) Metals, which were utilized at the system level.

The poorest system level regression results were obtained for Iron Ore and Iron and Steel (Group 8) where an R^2 value of .57656 was achieved

using Earnings in Contract Construction (XB17). Significant weaknesses also exist for the subsystem level analysis on the Ohio, Monongahela, Allegheny, and Cumberland Rivers in the downstream direction and on the Kanawha in both directions for this commodity group. However, only the Ohio and Monongahela Rivers transport significant volumes of these materials. There was quite a bit of variation in the entry of independent variables with Earnings in Mining (XB07), Coal Mining (XB08), and the Manufacture of Primary (XB13) and Fabricated (XB14) Metals playing important roles.

The last commodity group, consisting of those commodities not included in the first eight groups, had weak spots occurring on the Allegheny, Kanawha, and Tennessee Rivers in the downstream direction and on the Monongahela in both directions. Only the Tennessee and Monongahela Rivers carried significant traffic volumes. Earnings in Manufacturing, utilized in the system level regression equation for this commodity group was rather consistently chosen at the river level. Notable exceptions are the Ohio (other direction) and up the Tennessee, where in both cases Earnings in Wholesale and Retail Trade was utilized.

In an attempt to improve upon the weak spots identified above, in particular, those involving significant traffic volumes on the Allegheny, Monongahela, and Kanawha Rivers, we turn to the regression results obtained using local variables (Tables 31-36). In several instances local variables yielded much stronger correlations than those obtained using basin level independent variables. Specifically, for Coal and Coke traffic moving up the Monongahela, an R^2 value of .72869 was obtained with Earnings in the Manufacture of Fabricated Metals in BEA region 66 serving as the independent variable. For Aggregates moving up the Allegheny, an R^2 value of .68544 was attained utilizing Earnings in Primary and Fabricated Metals and Contract Construction in BEA region 66. Finally, employing Earnings in Manufacturing in BEA region 66, an R^2 value of .82097 was achieved for commodity group 9, All Other, moving up the Monongahela.

Further inspection of Tables 51-58 brings two general tendencies to light. First, the upstream traffic tends to follow the system's behavior more closely than the downstream traffic. This is especially true for the Allegheny, Monongahela, and Cumberland Rivers. Second, overall results on the Allegheny, Monongahela, and to a lesser extent, the Kanawha were not quite as good (in the sense of mirroring the system's behavior) as those obtained for the other rivers.

At the Key Lock and Dam Level, tests of the system level indepedent-dependent variable relationships yielded a similar degree of association as was obtained at the individual river level. Although it is difficult to compare the lock and dam results with the river results because the river regressions were made by direction while the lock and dam regressions had to be made in aggregate because of the data problem described in Section 2, one can safely assert that the lock and dam results tended to follow the results for the river on which the lock and dam is located. One exception that immediately stands out occurs on the Ohio River in the case of the Montgomery Lock and Dam Project. Regression results for this project were not nearly as good as those obtained for the Ohio River. A possible explanation lies in this project's location on the Ohio River close to Pittsburgh, where the Allegheny and Monongahela Rivers join to form the Ohio. Since the regression results for the downstream direction of both of these rivers did not follow the high level of correlation obtained at the system level of analysis, the lack of consistency for the Montgomery Locks and Dam are understandable.

Judging from the results of this analysis, it seems reasonable to utilize system level analysis, modified by local trends, to assign future traffic demand to the lock and dam projects in the ORB.

Table 51 : Comparison of Regression Results - System vs. Components
Commodity Group 1 - Coal and Coke

	Variable(s) Chosen and Associated F-Test		R^2	Equation F-Test	Standard Error As % of 1975 Tonnage
System Analysis	XB11/97.183	XB14/2.498	.96392	173.749	4.1
River Analysis:					
Ohio (Down)	XB11/70.609	XB08/14.608	.90417	51.895	8.3
Ohio (Up)	XB11/140.309		.92121	140.309	8.9
Ohio (Other)	XB13/73.025		.85886	73.025	8.2
Monongahela (Down)	XB13/8.280		.40830	8.280	10.4
Monongahela (Up)	XB13/17.313		.59063	17.313	20.1
Allegheny (Down)	XB08/19.603 XB13/3.103	XB14/7.567	.70838	8.097	24.5
Allegheny (Up)	XB15/28.169	XB13/5.309	.81255	23.841	19.7
Kanawha (Down)	XB08/23.714	XB14/11.435	.76911	18.321	11.9
Kanawha (Up)	XB13/5.018		.29487	5.018	28.3
Green (Down)	XB11/180.967	XB08/32.784	.96279	129.374	7.9
Cumberland (Down)	XB13/.182		.01982	.182	125.4
Cumberland (Up)	XB08/45.905		.86769	45.905	13.5
Tennessee (Down)	XB15/26.264	XB14/5.794	.93945	85.330	10.1
Tennessee (Up)	XB11/109.379		.90114	109.379	10.7

Table 51: Comparison of Regression Results - System vs. Components
Commodity Group 1 - Coal and Coke (Continued)

	Variable(s) Chosen and Associated F-Test		R^2	Equation F-Test	Standard Error As % of 1975 Tonnage
Key L&D's Analysis:					
Montgomery (Ohio)	XB08/6.210 XB11/5.960	XB13/6.314	.63469	5.791	16.5
L&D #52 (Ohio)	XB11/191.695		.94109	191.695	8.3
Kentucky L&D (Tennessee)	XB15/52.037	XB14/5.513	.90507	47.670	9.6
L&D #1 (Green)	XB11/141.650	XB08/25.289	.95282	100.972	7.0
Winfield L&D (Kanawha)	XB08/6.226	XB14/1.876	.58373	4.207	10.2
L&D #7 (Monongahela)	XB13/22.205		.64917	22.205	24.4
L&D #2 (Allegheny)	XB11/3.978	XB13/1.670	.42246	4.023	14.2
Gallipolis (Ohio)	XB11/37.427	XB08/5.045	.82174	25.355	9.6

Table 52: Comparison of Regression Results - System vs. Components
Commodity Group 2 - Petroleum Fuels

	Variable(s) Chosen and Associated F-Test		R^2	Equation F-Test	Standard Error As % of 1975 Tonnage
System Analysis:	XB15/8.822	XB02/5.799	.96243	140.904	5.1
River Analysis:					
Ohio (Down)	XB15/97.765		.89068	97.765	9.8
Ohio (Up)	XB02/175.336		.93594	175.336	6.4
Ohio (Other)	XB15/205.419		.94481	205.419	5.8
Monongahela (Down)	XB02/16.448	XB15/9.980	.65822	10.592	107.9
Monongahela (Up)	XB12/6.006	XB15/2.888	.83817	28.487	10.4
Allegheny (Down)	XB12/8.966	XB02/5.107	.44983	4.497	29.4
Allegheny (Up)	XB02/5.864		.32826	5.864	28.8
Kanawha (Down)	XB02/119.916	XB12/41.473	.92348	66.380	48.8
Kanawha (Up)	XB15/28.956	XB12/3.631	.94193	89.209	6.5
Cumberland (Down)	XB12/1.368		.13193	1.368	39.3
Cumberland (Up)	XB12/5.078	XB02/2.508	.32008	2.589	36.8
Tennessee (Down)	XB12/57.248		.82671	57.248	10.0
Tennessee (Up)	XB15/16.092		.57283	16.092	23.5
Key L&D's Analysis:					
Montgomery (Ohio)	XB02/10.526		.46727	10.526	14.8
L&D #52 (Ohio)	XB02/26.101		.68505	26.101	10.6
Kentucky (Tennessee)	XB02/7.533		.40645	7.533	26.4
Cheatham (Cumberland)	XB12/5.748		.45090	5.748	26.3
L&D #7 (Monongahela)	XB02/15.096		.55714	15.096	16.4
Gallipolis (Ohio)	XB02/50.331		.80748	50.331	10.7

Table 53: Comparison of Regression Results - System vs. Components
Commodity Group 4 - Aggregates

	Variable(s) Chosen and Associated F-Test		R^2	Equation F-Test	Standard Error As % of 1975 Tonnage
System Analysis:	XB17/93.803		.88658	93.803	9.1
River Analysis:					
Ohio (Down)	XB13/36.132		.75069	36.132	14.5
Ohio (Up)	XB17/54.377		.81921	54.377	14.2
Ohio (Other)	XB17/159.995		.93023	159.995	7.6
Monongahela (Down)	XB17/25.454		.66154	23.454	19.8
Monongahela (Up)	XB17/5.424		.31130	5.424	23.9
Allegheny (Down)	XB17/9.111		.43156	9.111	17.5
Allegheny (Up)	XB13/8.973	XB14/7.990	.46294	4.741	131.1
Kanawha (Up)	XB17/28.363		.70270	28.363	15.2
Kentucky (Up)	XB17/74.928		.86195	74.928	14.2
Tennessee (Down)	XB14/.655		.05174	.655	52.6
Tennessee (Up)	XB17/80.183		.86982	80.183	12.1
Key L&D's Analysis:					
Montgomery (Ohio)	XB14/4.18		.27565	4.186	20.5
Kentucky (Tennessee)	XB17/26.145		.70386	26.145	35.5
Cheatham (Cumberland)	XB13/13.278		.65480	13.278	13.3
L&D #1 (Kentucky)	XB17/17.540	XB14/2.024	.82776	24.029	15.8
Winfield (Kanawha)	XB17/9.659		.57981	9.659	15.5
L&D #7 (Monongahela)	XB17/24.788		.67381	24.788	21.8
L&D #2 (Allegheny)	XB17/5.282	XB14/1.926	.41743	3.941	19.4

Table 54: Comparison of Regression Results - System vs. Components
Commodity Group 5 - Grains

	Variable(s) Chosen and Associated F-Test	R^2	Equation F-Test	Standard Error As % of 1975 Tonnage
System Analysis:	XB16/19.147 XB06/12.540	.88187	41.059	12.5
River Analysis:				
Ohio (Down)	XB16/19.374	.61752	19.374	98.2
Ohio (Up)	XB06/13.615	.53152	13.615	50.0
Ohio (Other)	XB16/18.880	.61140	18.880	14.8
Tennessee (Down)	XB16/48.987 XB06/16.214	.81705	24.564	13.0
Tennessee (Up)	XB06/11.771	.49519	11.771	51.0
Key L&D's Analysis:				
None				

Table 55: Comparison of Regression Results - System vs. Components
Commodity Group 6 - Chemicals and Chemical Fertilizers

	Variable(s) Chosen and Associated F-Test		R^2	Equation F-Test	Standard Error As % of 1975 Tonnage
System Analysis:	XB09/60.394	XB06/7.307	.92313	66.046	12.5
River Analysis:					
Ohio (Down)	XB06/23.421	XB09/2.352	.85344	32.027	23.0
Ohio (Up)	XB09/133.359		.91745	133.359	12.8
Ohio (Other)	XB11/114.710		.90530	114.710	13.1
Monongahela (Down)	XB06/1.299		.09769	1.299	23.0
Monongahela (Up)	XB06/14.412		.54566	14.412	100.0
Allegheny (Up)	XB11/15.798		.58952	15.798	17.2
Kanawha (Down)	XB09/4.417 XB11/2.304	XB06/3.815	.82199	15.392	25.2
Kanawha (Up)	XB09/14.280	XB06/10.668	.87111	37.171	22.0
Cumberland (Down)	XB09/7.095		.41502	7.095	60.9
Cumberland (Up)	XB09/35.971		.74985	35.971	50.9
Tennessee (Down)	XB09/99.101		.89199	99.101	14.1
Tennessee (Up)	XB09/35.590		.74784	35.590	21.3
Key L&D's Analysis:					
L&D #52 (Ohio)	XB11/153.497		.93313	153.497	10.0
Gallipolis (Ohio)	XB09/4.605	XB06/1.414	.62851	8.459	30.0
Winfield (Kanawha)	XB06/12.037	XB11/9.701	.68287	6.460	11.4

Table 56: Comparison of Regression Results - System vs. Components
Commodity Group 7 - Ores and Minerals

	Variable(s) Chosen and Associated F-Test		R^2	Equation F-Test	Standard Error As % of 1975 Tonnage
System Analysis:	XB14/7.678	XB13/3.410	.83033	26.915	17.5
River Analysis:					
Ohio (Down)	XB07/15.977		.57108	15.977	48.3
Ohio (Up)	XB14/39.607		.76747	39.607	26.2
Ohio (Other)	XB13/29.817		.71303	29.817	20.2
Monongahela (Down)	XB07/18.091		.62187	18.091	30.4
Monongahela (Up)	XB14/19.405	XB13/4.110	.70111	12.901	41.8
Allegheny (Up)	XB09/13.048		.52091	13.048	43.5
Kanawha (Down)	XB13/8.799		.42305	8.799	91.7
Kanawha (Up)	XB14/2.494		.17206	2.494	52.7
Cumberland (Down)	XB13/7.686	XB07/2.247	.71695	6.332	26.2
Cumberland (Up)	XB07/19.959	XB14/14.048	.75074	16.565	21.7
Tennessee (Down)	XB09/7.654	XB13/4.642	.52798	6.152	35.4
Tennessee (Up)	XB09/49.672	XB07/3.956	.81870	24.836	24.9
Key L&D's Analysis:					
None					

Table 57: Comparison of Regression Results - System vs. Components
Commodity Group 8 - Iron Ore and Iron and Steel

	Variable(s) Chosen and Associated F-Test		R^2	Equation F-Test	Standard Error As % of 1975 Tonnage
System Analysis:	XB17/16.339		.57656	16.339	20.9
River Analysis:					
Ohio (Down)	XB17/2.497		.17226	2.497	34.2
Ohio (Up)	XB17/32.876	XB08/8.904	.82857	26.583	12.5
Ohio (Other)	XB13/13.649		.53215	13.649	22.7
Monongahela (Down)	XB08/1.216		.09202	1.216	41.0
Monongahela (Up)	XB14/21.324	XB07/5.875	.71665	13.911	28.7
Allegheny (Down)	XB14/.794		.06204	.794	110.0
Allegheny (Up)	XB08/10.366	XB07/7.630	.52986	6.199	31.0
Kanawha (Down)	XB08/1.607	XB14/1.434	.22417	1.589	100.0
Kanawha (Up)	XB13/3.980	XB07/3.115	.34260	2.866	114.3
Cumberland (Down)	XB13/6.190	XB14/1.862	.39865	3.646	45.2
Cumberland (Up)	XB17/28.271	XB08/3.873	.78226	19.759	19.6
Tennessee (Down)	XB17/3.220	XB13/2.995	.88223	41.200	14.0
Tennessee (Up)	XB17/29.628	XB08/7.033	.80822	23.178	19.7
Key L&D's Analysis:					
Montgomery (Ohio)	XB17/3.196		.21030	3.196	31.5
Gallipolis (Ohio)	XB17/5.703		.32217	5.703	24.6
L&D #2 (Allegheny)	XB08/11.348	XB07/8.400	.55054	6.737	30.0

Table 58: Comparison of Regression Results - System vs. Components
Commodity Group 9 - All Other

	Variable(s) Chosen and Associated F-Test		R^2	Equation F-Test	Standard Error As % of 1975 Tonnage
System Analysis:	XB09/186.807		.93964	186.807	8.1
River Analysis:					
Ohio (Down)	XB09/37.714		.75862	37.714	16.4
Ohio (Up)	XB09/40.654		.77210	40.654	21.8
Ohio (Other)	XB16/97.992		.89090	97.992	9.9
Allegheny (Down)	XB09/6.756		.36021	6.756	43.3
Allegheny (Up)	XB09/36.510		.75263	36.510	19.0
Kanawha (Down)	XB09/11.544		.49032	11.544	71.4
Kanawha (Up)	XB09/18.481	XB05/14.252	.71396	13.728	31.8
Cumberland (Down)	XB03/10.449	XB09/2.703	.83481	27.795	14.2
Cumberland (Up)	XB09/78.038		.86672	78.038	16.3
Tennessee (Down)	XB03/9.880		.45155	9.880	22.8
Tennessee (Up)	XB16/47.511		.79836	47.511	19.2
Monongahela (Down)	XB09/1.295	XB03/1.016	.11986	.749	89.0
Monongahela (Up)	XB09/3.288	XB05/2.150	.40748	3.782	37.5
F L&D's Analysis:					
L&D #52 (Ohio)	XB09/59.713		.83267	59.713	15.5
L&D #2 (Allegheny)	XB16/204.184		.94449	204.184	8.9
Kentucky (Tennessee)	XB16/18.709	XB09/8.965	.85265	28.933	12.0
Cheatham (Cumberland)	XB16/7.299	XB09/2.847	.83608	15.302	20.6

3.2 System Level Demand Projections

In Section 2.3.1 of this report three separate commodity specific regressions of system traffic were described. The first utilized GNP as the independent variable and used all thirty-six years (1940-1975) of commodity data. The other two used fourteen years of data, weighted toward the more recent years, one relying on national level earnings and income independent variables, the other on the same variables at the basin level The projections obtained as a result of this analysis appear in Tables 60-67.

In applying Shift-Share analysis to arrive at future O-D flows, system-wide total and commodity group tonnage figures for 1980, 1985, and 1990 had to be chosen. Given the above three choices, it was decided that the linear projections based upon fourteen years of data and basin level variables would be most appropriate. Although it could be argued that projections made using thirty-six data points would tend to be more accurate than those based upon fourteen, we felt that since these fourteen points represented the most recent data, they best depicted the current physical characteristics and constraints (lock and dam projects, canals, etc.) of the Ohio River System as well as more recent economic institutional and technological considerations that are inputs to decisions to transport by river barge. The basin level projections were felt to be superior to the national level projections because of the stronger connection present between traffic and the basin's economy. The equations and associated projections selected for use in the Shift-Share procedure appear in Table 59.

It is interesting to note that although the basin level projections differed somewhat from the national level (fourteen points) projections, the total tonnage figures obtained by summing the individual commodity group projections turned out to be remarkably similar. In addition, separate projections of total tonnage with the commodity groups combined were made using national and basin level variables and these values were quite consistent with each other and with the total tonnage projections obtained by summing the individual commodity groups (see Table 68 for details).

Although projections were obtained for Commodity Group 8, the R^2 value for this group was significantly lower than those obtained for the other commodity groups. One possible explanation for this lies in the effect on domestic steel production (and thus on the raw materials, especially iron ore, that serve as inputs to steel production) that has been

Table 59: System Level Projections Chosen for Use in Shift-Share Analysis*

Commodity Group	Equation	R^2	Projections** 80	85	90
Coal and Coke	Y=-31,672,927 +102,596XB11-28,783XB14	.96392	117,031	146,605	182,256
Petroleum Fuels	Y=-58,465,846+ 5800XB15 + 3440XB02	.96243	24,312	30,565	37,663
Aggregates	Y=-4,284,360 + 8750 XB17	.88658	27,845	33,296	39,727
Grains	Y=-16,300 + 773XB16 -2690 XB06	.88187	3,354	4,317	5,456
Chemicals and Chemical Fertilizers	Y=-10,499,211 + 1460XB09 - 2087 XB06	.92313	13,333	17,604	22,639
Ores and Minerals	Y=-6,213,546 +5664XB14+1494 XB13	.83033	6,294	7,890	9,739
Iron Ore and Iron and Steel	Y=-273,520 + 1775XB17	.57656	6,244	7,350	8,655
All Other	Y=-11,513,842 + 1361 XB09	.93964	13,041	17,090	21,854

*All equations chosen were linear with basin level independent variables.
**Thousands of tons.

Table 60 : Demand Projections: System Level - Commodity Group 1 - Coal and Coke
1975 Tonnage* = 98,236

Equation	Projections*		
	1980	1985	1990
Linear: Y = 8530712 + 70140 GNP	GNP = 1,505.6 114,133	GNP = 1,795.8 134,488	GNP = 2,086 154,842
Geometric: LnY = 13.01285 + .74225 Ln (GNP)	102,344	116,649	130,368
Linear: Y = .17820 XN05 - 32,218,016	XN05 = 837,490,000 117,023	XN05 = 992,723,000 144,685	XN05 = 1,176,711,000 177,472
Geometric: LnY = -37.80132 + 4.08659 Ln (XN05) -3.80762 Ln (XN04) + .28984 Ln (XN07)	XN04 = 4700 XN07 = 6,498,000 109,728	XN04 = 5400 XN07 = 6,896,300 131,829	XN04 = 6100 XN07 = 7,319,000 168,927
Linear: Y = -31,672,927 + 102,596 XB11 - 28,783 XB14	XB11 = 1,875 XB14 = 1,517 117,031	XB11 = 2,232 XB14 = 1,762 146,605	XB11 = 2,660 XB14 = 2,049 182,256
Geometric: LnY = .0443 + 1.6496 Ln (XB11) - 0.3777 Ln (XB14)	107,773	135,776	171,397

*Thousands of tons, projections are underlined.

Table 61 : Demand Projections: System Level - Commodity Group 2 - Petroleum Fuels
1975 Tonnage* = 18,846

Equation	Projections* 1980	Projections* 1985	Projections* 1990
Linear: $Y = -305,935 + 15,204\ GNP$	GNP = 1505.6 22,585	GNP = 1795.8 26,997	GNP = 2086 31,409
Parabolic: $Y = -2071004 + 20694\ GNP - 3.64321\ (GNP)^2$	20,828	23,343	25,244
Linear: $Y = .57211\ XN15 - 10,403,156$	XN15 = 58,672,000 23,164	XN15 = 69,036,800 29,093	XN15 = 81,233,000 36,071
Geometric: $LnY = -21.65735 + 2.16845\ Ln\ (XN15)$	27,017	29,907	42,558
Linear: $Y = -58,465,846 + 5800\ (XB15) + 3440\ (XB02)$	XB15 = 3,818 XB02 = 17,626 24,312	XB15 = 4,468 XB02 = 18,348 30,565	XB15 = 5,235 XB02 = 19,118 37,663
Parabolic: $Y = -33,054,134 + 5392\ (XB15) + 0.1\ (XB02)^2$	18,600	24,702	31,723

*Thousands of tons, projections are underlined.

Table 62 : Demand Projections: System Level - Commodity Group 4 - Aggregates
1974 Tonnage* = 22,098

Equations	Projections* 1980	1985	1990
Linear: Y = 3,163,569 + 16,385 GNP	GNP = 1505.6 27,833	GNP = 1795.8 32,588	GNP = 2086 37,343
Exponential: LnY = 15.63877 + .0014 GNP	34,455	47,965	66,773
Linear: Y = .63418 XN17 - 4,869,195	XN17 = 51,910,000 28,051	XN17 = 60,857,100 33,725	XN17 = 71,347,000 40,378
Geometric: LnY = -14.39012 - 2.05881 Ln (XN04) +2.75465 Ln (XN17)	XN04 = 4,700 27,741	XN04 = 5,400 32,301	XN04 = 6,100 38,947
Linear: Y = -4,284,360 + 8750 XB17	XB17 = 3,672 27,845	XB17 = 4,295 33,296	XB17 = 5,030 39,727
Geometric: LnY = 7.16848 + 1.21284 Ln (XB17)	27,346	33,070	40,054

*Thousands of tons, projections are underlined.

Table 63: Demand Projections: System Level - Commodity Group 5 - Grains
1975 Tonnage* = 4,097

Equations	Projections* 1980	1985	1990
Linear: $Y = -1{,}716{,}337 + 4430\ GNP$	GNP = 1505.6 4,953	GNP = 1795.8 6,238	GNP = 2086 7,524
Geometric: $LnY = -4.35944 + 2.74916\ Ln\ (GNP)$	6,962	11,303	17,063
Linear: $Y = -9098492 + .87200\ XN10$	XN10 = 16,016,000 4,867	XN10 = 17,444,400 6,113	XN10 = 19,000,000 7,470
Other curves inappropriate for projection purposes.			
Linear: $Y = -16{,}300 + 773\ (XB16) - 2690\ (XB06)$	XB16 = 8,543 XB06 = 1,202 3,354	XB16 = 9,911 XB06 = 1,237 4,317	XB16 = 11,509 XB06 = 1,273 5,456
Parabolic: $Y = -1{,}210{,}604 + 735\ (XB16) - 1\ (XB06)^2$	3,624	4,544	5,628

*Thousands of tons, projections are underlined.

Table 64: Demand Projections: System Level - Commodity Group 6 - Chemicals and Chemical Fertilizers
1973 Tonnage* = 10,591

Equations	Projections* 1980	1985	1990
Linear: Y = -5,034,763 + 12,717 GNP	GNP = 1505.6 <u>14,112</u>	GNP = 1795.8 <u>17,802</u>	GNP = 2086 <u>21,493</u>
Geometric: LnY = -.84574 + 2.39558 Ln (GNP)	<u>17,586</u>	<u>26,825</u>	<u>38,405</u>
Linear: Y = -12,427,173 + .03232 XN05	XN05 = 837,490,000 <u>14,641</u>	XN05 = 992,723,000 <u>19,658</u>	XN05 = 1,176,711,000 <u>25,604</u>
Geometric: LnY = -44.54767 + 3.71028 Ln (XN11)	XN11 = 15,632,000 <u>22,131</u>	XN11 = 18,774,600 <u>43,669</u>	XN11 = 22,549,000 <u>86,170</u>
Linear: Y = -10,499,211 + 1,460 (XB09) - 2087 (XB06)	XB09 = 18,042 XB06 = 1,202 <u>13,333</u>	XB09 = 21,017 XB06 = 1,237 <u>17,604</u>	XB09 = 24,517 XB06 = 1,273 <u>22,639</u>
Geometric: LnY = -39.3341 + 4.1286 Ln (XB09) -0.9400 Ln (XB06)	<u>14,472</u>	<u>26,457</u>	<u>48,659</u>

*Thousands of tons, projections are underlined.

Table 65: Demand Projections: System Level - Commodity Group 7 - Ores and Minerals
1975 Tonnage* = 3,446

Equations	Projections*		
	1980	1985	1990
Linear: Y = 1,365,944 + 4374 GNP	GNP = 1505.6 <u>5,220</u>	GNP = 1795.8 <u>6,489</u>	GNP = 2086 <u>7,758</u>
Geometric: LnY = .46315 + 2.08659 Ln (GNP)	<u>6,788</u>	<u>9,805</u>	<u>13,403</u>
Linear: Y = -3,304,872 + .00995 XN05	XN05 = 837,490,000 <u>5,028</u>	XN05 = 992,723,000 <u>6,573</u>	XN05 = 1,176,711,000 <u>8,403</u>
Geometric: LnY = -49.84333 - 1.29460 Ln (XN07) +5.16566 Ln (XN13)	XN07 = 6,498,000 XN13 = 14,302,000 <u>3,132</u>	XN07 = 6,896,300 XN13 = 15,317,000 <u>4,132</u>	XN07 = 7,319,000 XN13 = 16,404,000 <u>5,452</u>
Linear: Y = -6,213,546 + 5664 (XB14) + 1494 (XB13)	XB14 = 1,517 XB13 = 2,621 <u>6,294</u>	XB14 = 1,762 XB13 = 2,760 <u>7,890</u>	XB14 = 2,049 XB13 = 2,910 <u>9,739</u>
Geometric: LnY = -42.9451 + 4.1445 Ln (XB09) -0.7407 Ln (XB07)	XB09 = 18,042 XB07 = 1,370 <u>7,541</u>	XB09 = 21,017 XB07 = 1,484 <u>13,377</u>	XB09 = 24,517 XB07 = 1,609 <u>23,858</u>

*Thousands of tons, projections are underlined.

Table 66: Demand Projections: System Level - Commodity Group 8 - Iron Ore and Iron and Steel
1974 Tonnage* = 5,125

Equations	Projections* 1980	1985	1990
Linear: Y = 1,318,177 - 3212 GNP	GNP = 1505.6 <u>6,154</u>	GNP = 1795.8 <u>7,086</u>	GNP = 2086 <u>8,018</u>
Exponential: Ln Y = 14.30158 + .00101 GNP	<u>7,439</u>	<u>9,972</u>	<u>13,369</u>
Linear: Y = -721,544 + .00850 XN05	XN05 = 837,490,000 <u>5,397</u>	XN05 = 992,723,000 <u>7,717</u>	XN05 = 1,176,711,000 <u>9,281</u>
Geometric: LnY = -9.47670 + 1.22392 Ln (XN05)	<u>6,388</u>	<u>7,865</u>	<u>9,684</u>
Exponential: LnY = 13.23541 + .15341 XN13A**	XN13A = 14.302 <u>5,023</u>	XN13A = 15.317 <u>5,869</u>	XN13A = 16.404 <u>6,934</u>
Linear: Y = -273,520 + 1775 (XB17)	XB17 = 3,672 <u>6,244</u>	XB17 = 4,295 <u>7,350</u>	XB17 = 5,030 <u>8,655</u>
Geometric: LnY = -11.80066 + 1.09924 Ln (XB13) +0.79178 Ln (XB14)	XB13 = 2,620,600 XB14 = 1,517,000 <u>6,674</u>	XB13 = 2,759,700 XB14 = 1,762,100 <u>7,954</u>	XB13 = 2,910,100 XB14 = 2,049,100 <u>9,501</u>

*Thousands of tons, projections are underlined.
**Where XN13A = XN13/1,000,000.

Table 67: Demand Projections: System Level - Commodity Group 9 - All Others
1975 Tonnage* = 10,316

Equations	Projections* 1980	1985	1990
Linear: Y = -3,493,245 + 10.561 GNP	GNP = 1505.6 <u>12,407</u>	GNP = 1795.8 <u>15,472</u>	GNP = 2086 <u>18,537</u>
Geometric: LnY = 4.1317 + 1.65715 Ln (GNP)	<u>11,490</u>	<u>15,388</u>	<u>19,723</u>
Linear: Y = -11,492,375 + .18122 XN16	XN16 = 133,912,000 <u>12,775</u>	XN16 = 154,867,400 <u>16,573</u>	XN16 = 179,102,000 <u>20,964</u>
Geometric: LnY = -55.30756 + 3.74169 Ln (XN09)	XN09 = 219,486,000 <u>15,531</u>	XN09 = 252,984,700 <u>26,424</u>	XN09 = 291,595,000 <u>44,959</u>
Linear: Y = -11,513,842 + 1361 (XB09)	XB09 = 18,042 <u>13,041</u>	XB09 = 21,017 <u>17,090</u>	XB09 = 24,517 <u>21,854</u>
Parabolic: Y = -15,716,172 + 2231 (XB09) -0.04 $(XB09)^2$	<u>11,515</u>	<u>13,504</u>	<u>14,938</u>
Geometric: LnY = -38.79900 + 7.37237 Ln (XB09) -3.80329 Ln (XB05)	XB09 = 18,041,900 XB05 = 57,208,000 <u>13,866</u>	XB09 = 21,016,800 XB05 = 67,928,600 <u>22,228</u>	XB09 = 24,517,100 XB05 = 80,733,900 <u>35,882</u>

*Thousands of tons, projections are underlined.

Table 68: Projections* of Basinwide Total Tonnage (Demand)

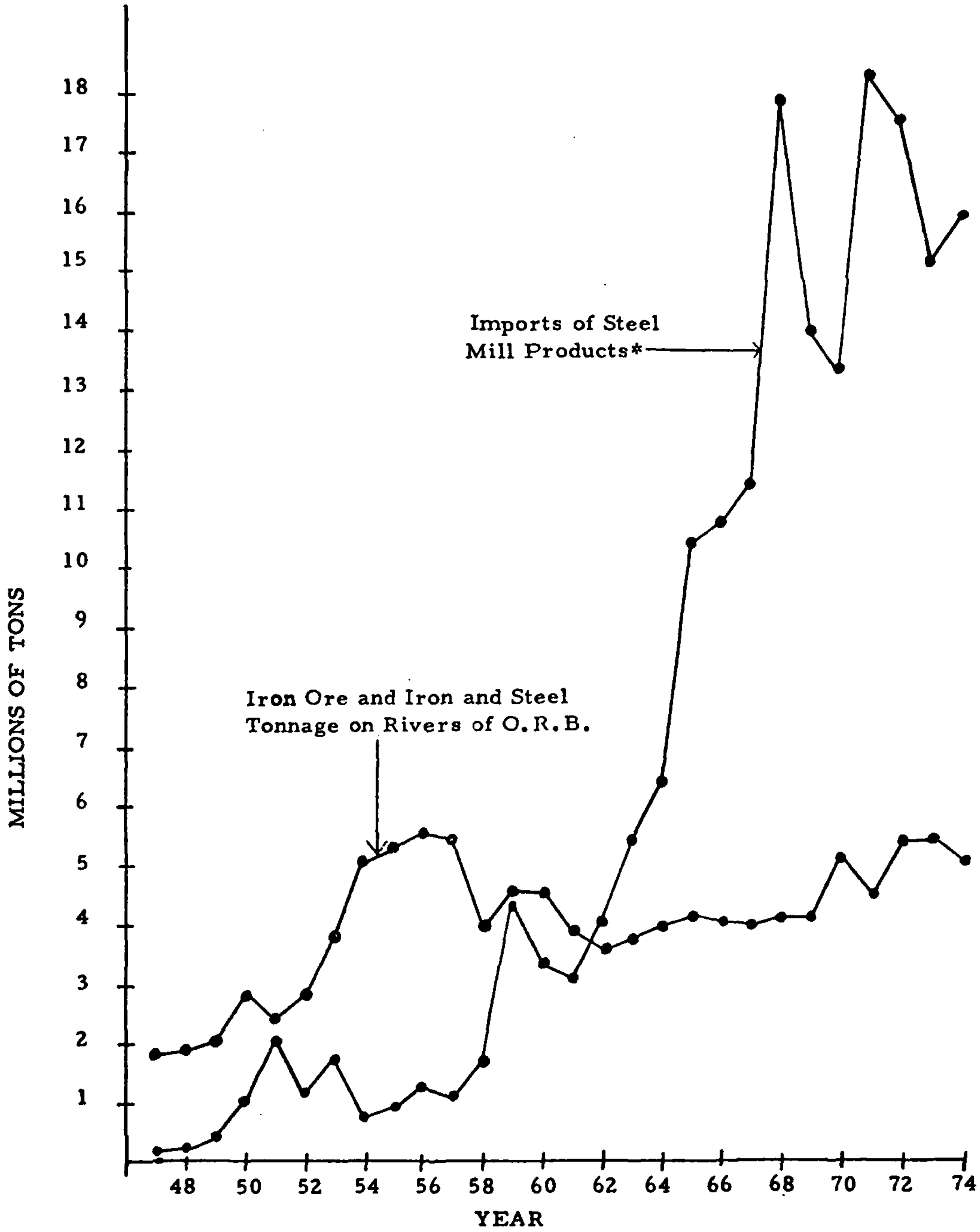
Projection Procedure	1980	1985	1990
1. Sum of individual commodity group projections, national level independent variables	210,946	264,137	325,643
2. Sum of individual commodity group projections, basin level independent variables**	211,454	264,717	327,989
3. Linear Regression Y= 35,138 XN05 - 76,311,965	217,965	272,511	337,161
4. Linear Regression Y=69 XB02 - 992,455	223,739	273,557	326,687

*Thousands of Tons
**These values were used as the total tonnage projections in the shift-share procedure.

caused by a rapid increase in the imports of steel mill products. The plot of imports of steel mill products and iron ore and iron and steel tonnage on the rivers of the ORB, both versus time (Figure 6), illuminates some interesting patterns. Between 1947 and 1957 when steel imports were low, the tonnage trend was generally upward. However, the rapid increase in imports which began in 1958 and increased rapidly over the next ten years corresponds with a drop and subsequent leveling off of Commodity Group 8 tonnage. It is also interesting to note that sharp increases in imports often correspond to drops in Commodity Group 8 tonnages (1950-1951, 1961, 1962, 1970-1971, 1973-1974) and vice versa (1951-1952, 1971-1972).

Given these patterns, it seem that a fairly strong inverse relationship exists between the imports of steel mill products and the tonnage of Commodity Group 8 moving on the waterways of the ORB. In fact, summing the tonnages of these two variables for each year from 1947 to 1974 and then running a simple time series regression on the resulting series of tonnages yields an R^2 value of .89628. Therefore, although Commodity Group 8 tonnage projections have been made (see Table 59) one should be aware of the fact that this commodity group is very sensitive to the amount of steel mill products imported. Since imports are quite dependent on government policy, a shift in policy regarding imports, could result in a change in Commodity Group 8 tonnage, e.g., an increase in tariffs could cause a decrease in steel mill products imports and a resulting increase in Commodity Group 8 tonnage. Thus, the forecasts of Commodity Group 8 tonnage derived in this study, should be reviewed as government policy in this matter evolves.

Figure 6: Imports of Steel Mill Products and Commodity Group 8 (Iron Ore and Iron and Steel) Tonnages vs. Time



*from Business Statistics, 1975 Biennial Edition

3.3 Assignments of O-D Flows to Rivers and L&D Projects

The tonnages appearing in the 1980, 1985, and 1990 columns of the Tables in this section are the result of running the commodity specific future O-D matrices developed by the Shift-Share and Fratar procedures through the traffic assignment program. The tonnages appearing after "Base Year Assignment" at the bottom of each table result from taking the observed base year flows (1975 for commodity groups 5 and 6, 1976 for the other groups) utilized in the Fratar procedure and running them through the traffic assignment program. This base year assignment was performed mainly as a check to help determine the accuracy of the assignment procedure. By comparing the total tons obtained as a result of the assignment with the observed 1976 tonnage* which also appears on each table, one can see that in most cases the assignment procedure yields results quite close to those actually observed.

It should be noted that the actual O-D matrices at the PE and BEA level of analysis are not included in this report due to the voluminous nature of the material. They are, however, available for review in the Huntington District office of the Corps of Engineers.

*The fact that the base year data included 1975 flows for groups 5 and 6 should not effect the comparison to any great degree since those groups comprise a relatively small portion of total traffic.

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PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Barkley Canal

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	4,569	4,569	0	3,105	17	3,088	3,480	31	3,449	3,913	47	3,866
2	163	163	-	1,906	1,617	289	2,469	2,082	387	3,169	2,656	513
4	71	71	0	1,722	1,722	0	1,879	1,879	0	1,970	1,970	0
5	0	-	0	59	0	59	92	0	92	155	0	155
6	10	10	0	376	268	108	511	357	154	693	471	222
7	4	4	0	191	54	137	317	77	240	502	111	391
8	0	0	0	505	345	160	667	454	213	875	596	279
9	8	8	0	856	596	260	1,170	797	373	1,555	1,030	525
3	163	163	0	0	0	0	0	0	0	0	0	0
Total	4,988	4,988	0	8,720	4,619	4,101	10,585	5,677	4,908	12,832	6,881	5,951

Base Year Assignment** = 7,478

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Up = Tennessee to Cumberland
Down = Cumberland to Tennessee

PROJECTED LOCK AND DAM TRAFFIC

OHIO RIVER

PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Ohio River L&D #52 (mile 938.9)

Com- modity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	18,558	3,922	14,636	20,377	4,294	16,083	24,604	5,160	19,444	29,205	6,062	23,143
2	10,000	8,850	1,150	12,806	11,265	1,541	15,981	14,061	1,920	19,500	17,144	2,356
4	1,973	72	1,901	2,701	19	2,682	3,428	21	3,407	4,213	24	4,189
5	5,051	1,340	3,711	3,216	921	2,295	4,127	1,025	3,102	5,170	1,102	4,068
6	7,510	6,567	943	9,281	7,932	1,349	12,294	10,454	1,840	15,827	13,324	2,503
7	3,131	3,008	123	5,716	5,475	241	6,876	6,554	322	8,006	7,586	420
8	3,282	1,974	1,308	4,760	2,901	1,859	5,535	3,438	2,097	6,405	4,055	2,350
9	8,047	3,353	4,694	10,111	4,382	5,728	13,077	5,571	7,506	16,392	6,865	9,527
3	881	881	0	2,000	2,000	0	0	0	0	0	0	0
Total	58,433	29,967	28,466	70,968	39,190	31,778	85,922	46,284	39,638	104,718	56,162	48,556

Base Year Assignment** =54,953

*Thousands of tons.

**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

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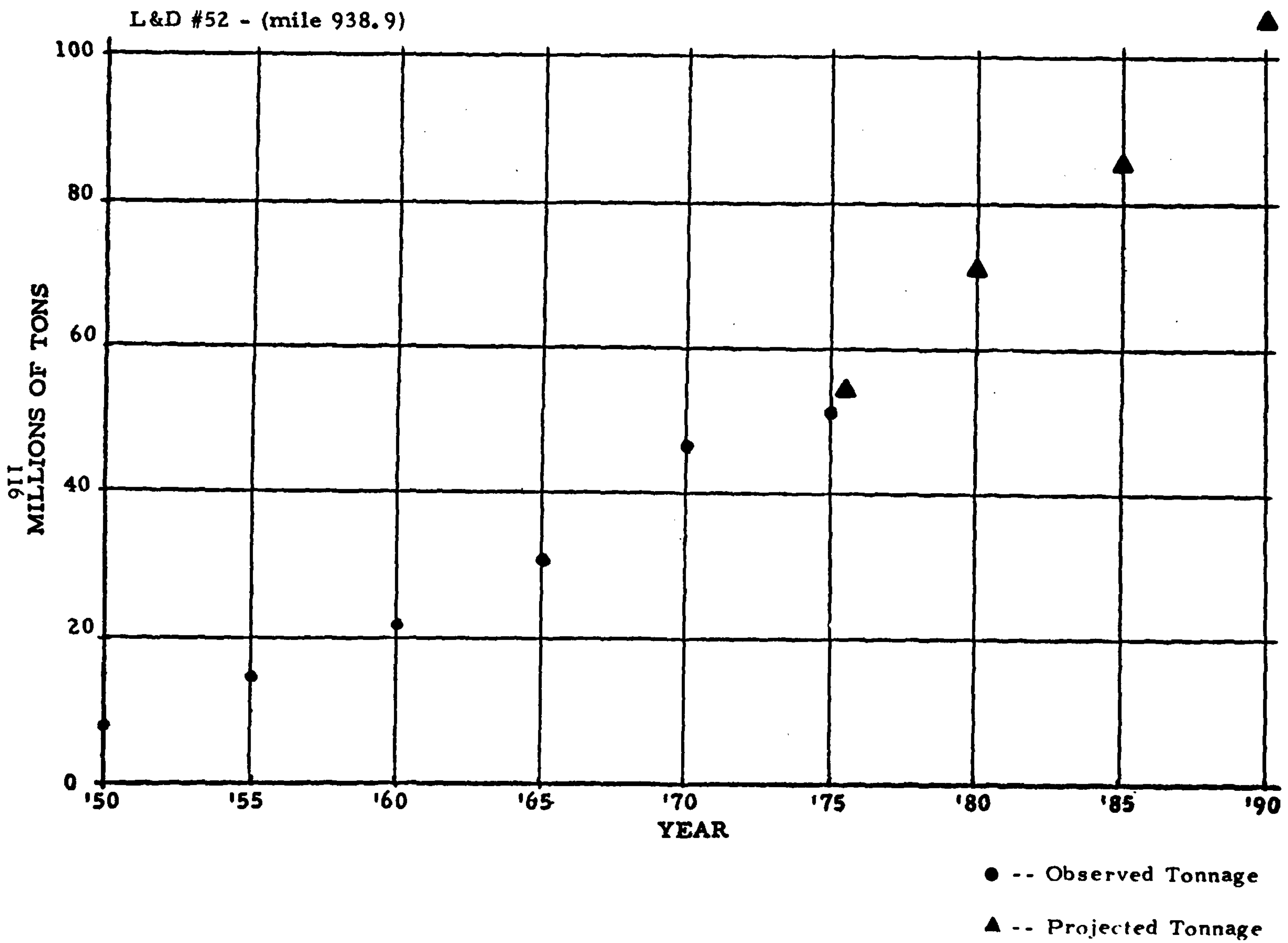
L&D #52 - (mile 938.9)
MILLIONS OF TONS
100
80
60
40
20
0
'50
'55
'60
'65
'70
'75
'80
'85
'90
YEAR
● -- Observed Tonnage
▲ -- Projected Tonnage

PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Ohio River L&D #53 (mile 962.6)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	15,282	2,669	12,613	16,873	2,924	13,949	20,456	3,512	16,944	24,384	4,125	20,259
2	9,999	8,849	1,150	12,806	11,265	1,541	15,980	14,061	1,919	19,500	17,144	2,356
4	1,272	107	1,165	1,706	19	1,687	2,246	21	2,225	2,833	24	2,809
5	5,051	1,340	3,711	3,216	921	2,295	4,126	1,024	3,102	5,170	1,102	4,068
6	7,510	6,567	943	9,281	7,932	1,349	12,293	10,453	1,840	15,827	13,324	2,503
7	3,131	3,008	123	5,715	5,475	240	6,876	6,554	322	8,006	7,586	420
8	3,280	1,974	1,306	4,759	2,901	1,858	5,533	3,438	2,095	6,403	4,055	2,348
9	8,227	3,472	4,755	9,955	3,919	6,036	12,901	5,011	7,890	15,996	6,000	9,996
3	881	881	0	2,000	2,000	0	0	0	0	0	0	0
Total	54,633	28,867	25,766	66,311	37,356	28,955	80,411	44,074	36,377	98,119	53,360	44,759

Base Year Assignment** = 50,856

*Thousands of tons.

**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

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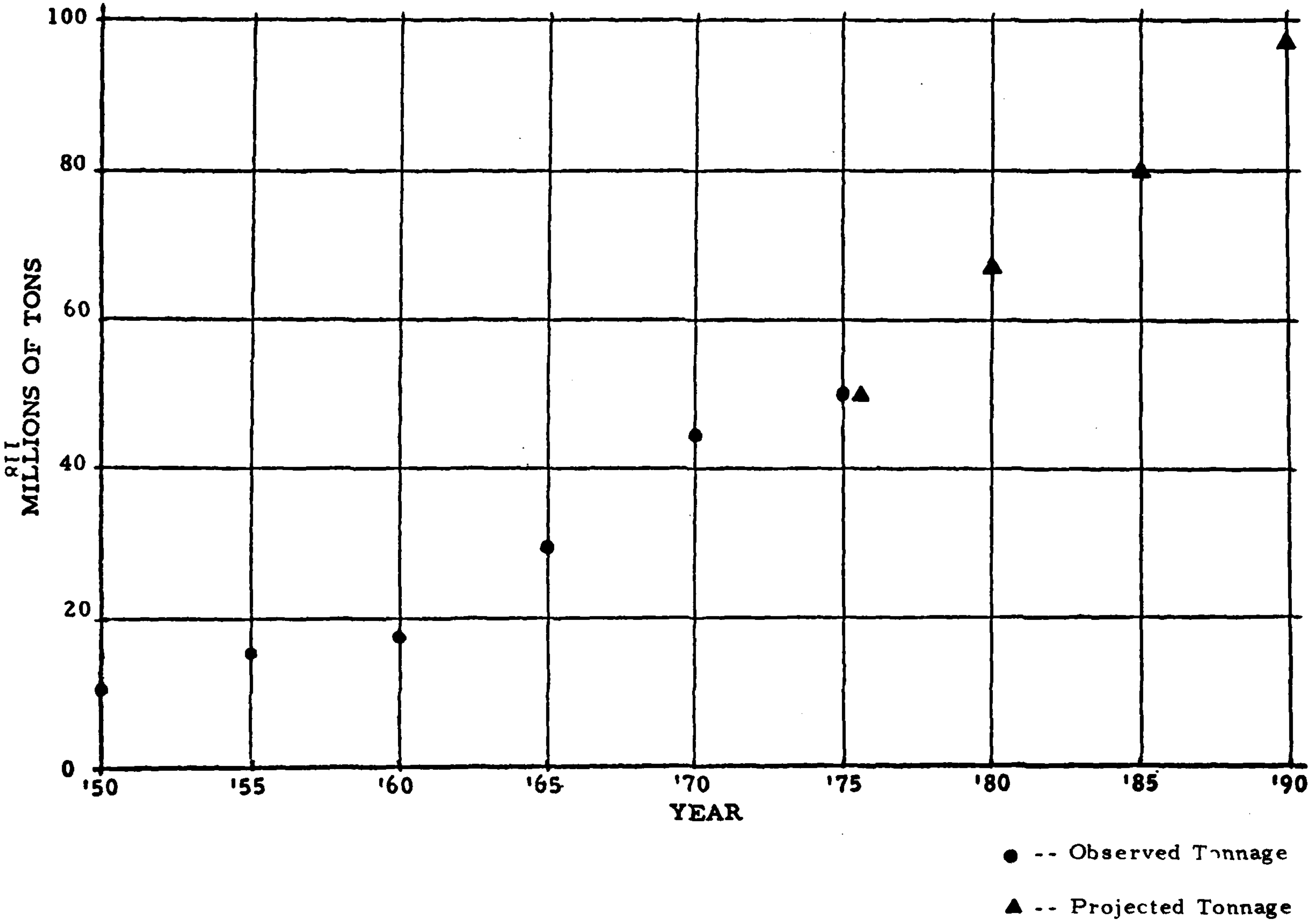
L&D #53 - (mile 962.6)



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Ohio River Smithland L&D (mile 918.5)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	23,400	3,481	19,919	26,083	3,781	22,302	32,056	4,492	27,564	38,820	5,200	33,620
2	7,821	6,203	1,618	9,892	7,798	2,094	12,348	9,812	2,536	15,115	12,124	2,991
4	793	86	707	1,024	56	968	1,238	70	1,168	1,461	80	1,381
5	3,842	163	3,679	2,424	107	2,317	3,275	124	3,151	4,316	139	4,177
6	5,478	4,806	672	6,909	5,853	1,056	9,052	7,548	1,504	11,582	9,407	2,175
7	2,392	2,168	224	4,386	3,923	463	5,494	4,813	681	6,702	5,738	964
8	2,971	1,620	1,351	4,238	2,329	1,909	4,930	2,748	2,182	5,728	3,247	2,481
9	3,557	2,484	1,073	4,460	3,000	1,460	5,785	3,848	1,937	7,366	4,834	2,532
3	883	883	0	2,000	2,000	0	0	0	0	0	0	0
Total	51,137	21,894	29,243	61,416	28,847	32,569	74,178	33,455	40,723	91,090	40,769	50,321

Base Year Assignment** = 47,985

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

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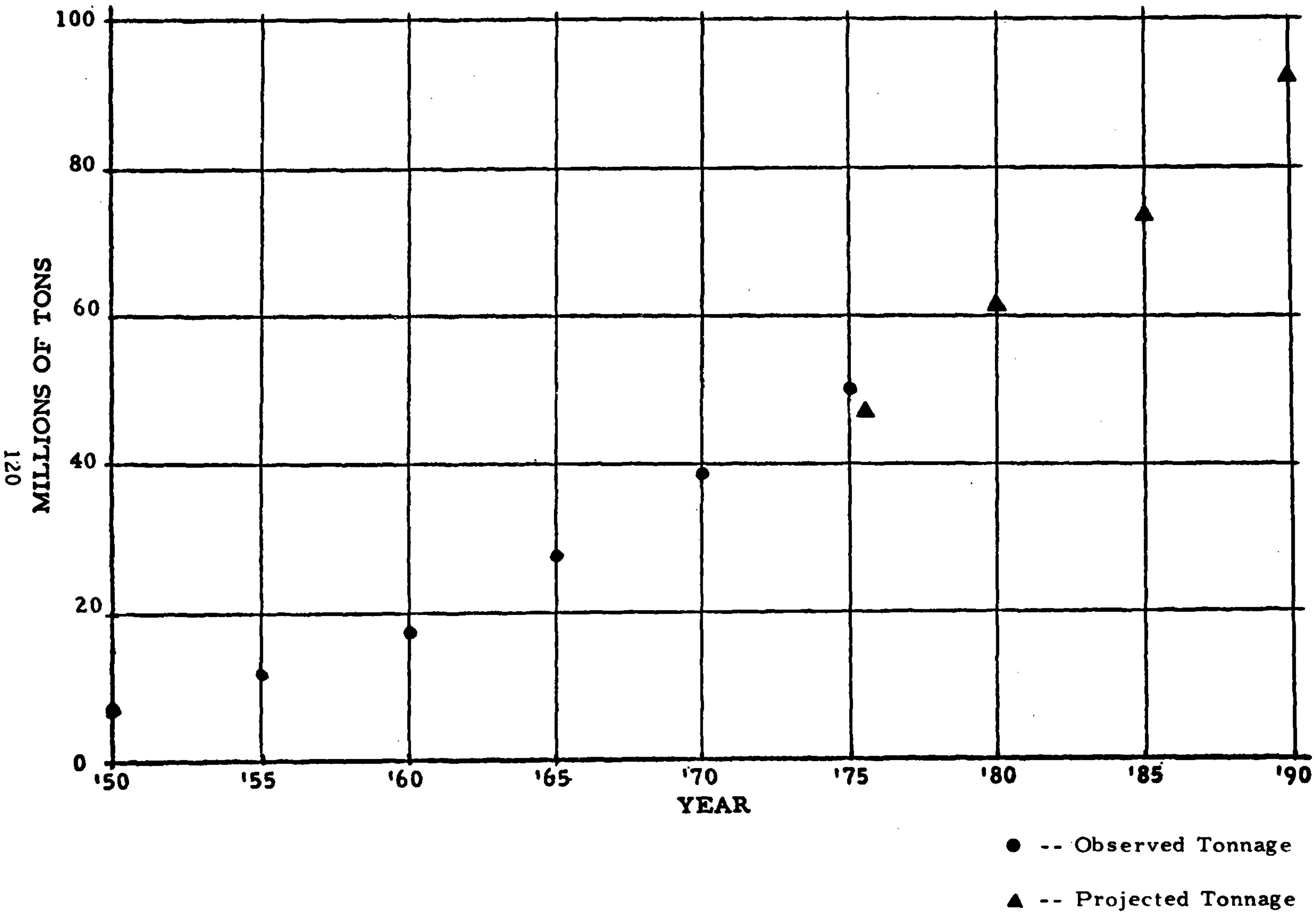
Smithland L&D - (mile 918.5)



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Ohio River Uniontown L&D (mile 846.0)

Com-modity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	18,922	3,554	15,368	21,386	3,851	17,535	26,611	4,560	22,051	32,630	5,259	27,371
2	7,821	6,203	1,618	9,892	7,798	2,094	12,348	9,812	2,523	15,115	12,124	2,991
4	108	86	22	79	55	24	95	68	27	108	78	30
5	3,534	165	3,369	2,307	107	2,200	3,132	124	3,008	4,147	139	4,008
6	5,478	4,806	672	6,907	5,851	1,056	9,049	7,545	1,504	11,597	9,404	2,175
7	2,391	2,179	212	4,398	3,955	443	5,557	4,884	673	6,827	5,853	874
8	2,971	1,620	1,351	4,238	2,329	1,909	4,930	2,748	2,182	5,728	3,247	2,481
9	3,398	2,334	1,064	4,293	2,857	1,436	5,523	3,620	1,903	6,966	4,478	2,488
3	883	883	0	2,000	2,000	0	0	0	0	0	0	0
Total	45,506	21,830	23,676	55,500	28,803	26,697	67,245	33,361	33,884	83,118	40,582	42,536

Base Year Assignment** ≈ 42,313

*Thousands of tons.

**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

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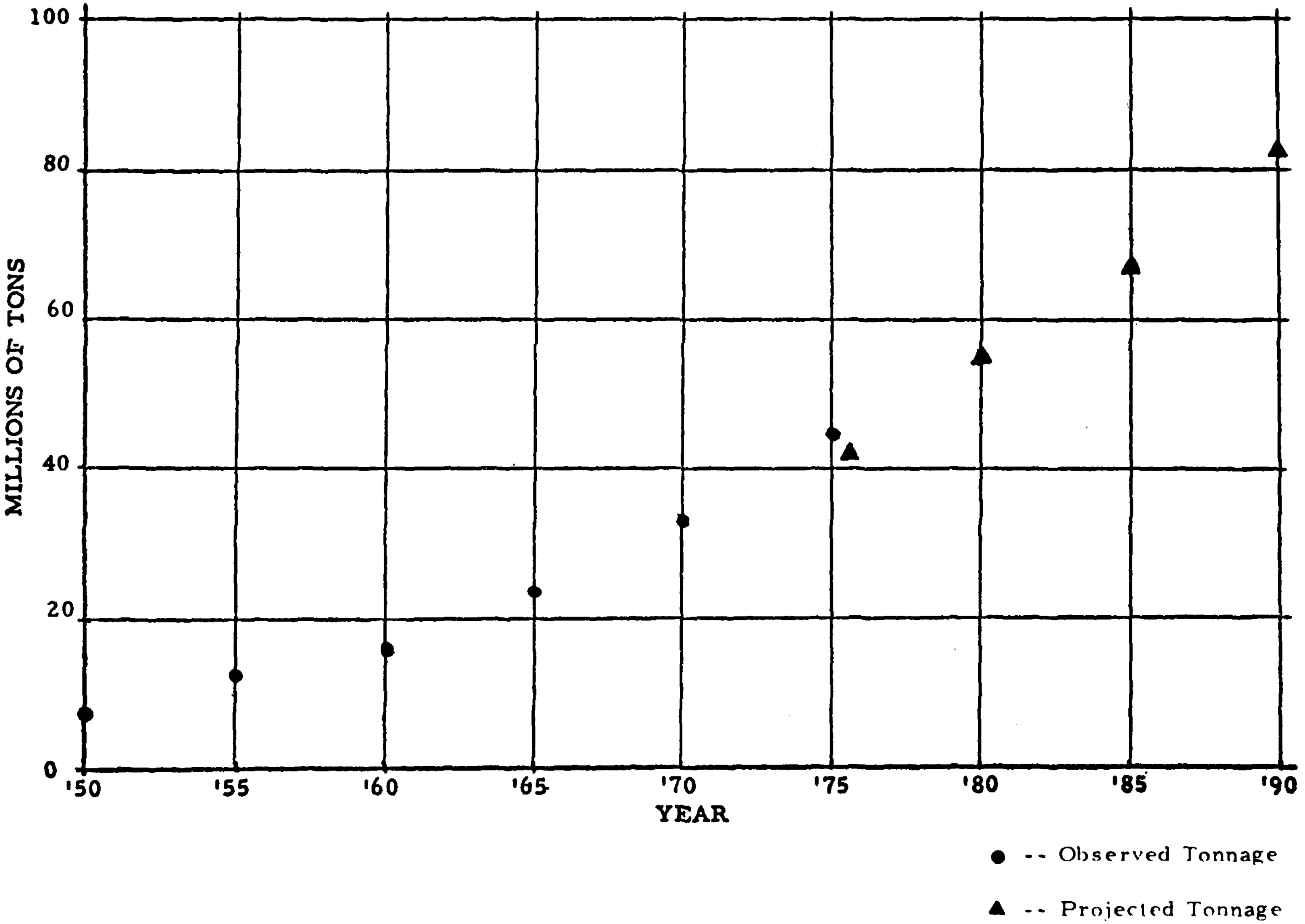
Uniontown L&D - (mile 846.0)



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Ohio River Newburgh L&D (mile 776.1)

Com-modity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	14,712	10,599	4,113	16,433	11,433	5,000	20,344	13,638	6,706	24,958	16,031	8,927
2	7,023	6,658	365	8,706	8,226	480	10,844	10,270	574	13,257	12,588	669
4	562	84	478	607	54	553	603	67	536	557	76	481
5	1,633	30	1,603	977	14	963	1,428	16	1,413	2,035	19	2,016
6	5,187	4,544	643	6,258	5,430	828	7,978	6,926	1,052	9,982	8,677	1,305
7	2,369	2,158	211	4,383	3,942	441	5,541	4,869	672	6,809	5,837	972
8	3,031	1,643	1,388	5,019	2,797	2,222	5,048	2,813	2,235	5,874	3,344	2,530
9	3,087	2,488	619	5,158	4,089	1,069	4,918	3,899	1,019	6,147	4,896	1,251
3	399	399	0	2,000	2,000	0	0	0	0	0	0	0
Total	38,003	28,583	9,420	49,541	37,985	11,556	56,704	42,498	14,206	69,619	51,468	18,151

Base Year Assignment** = 35,855

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

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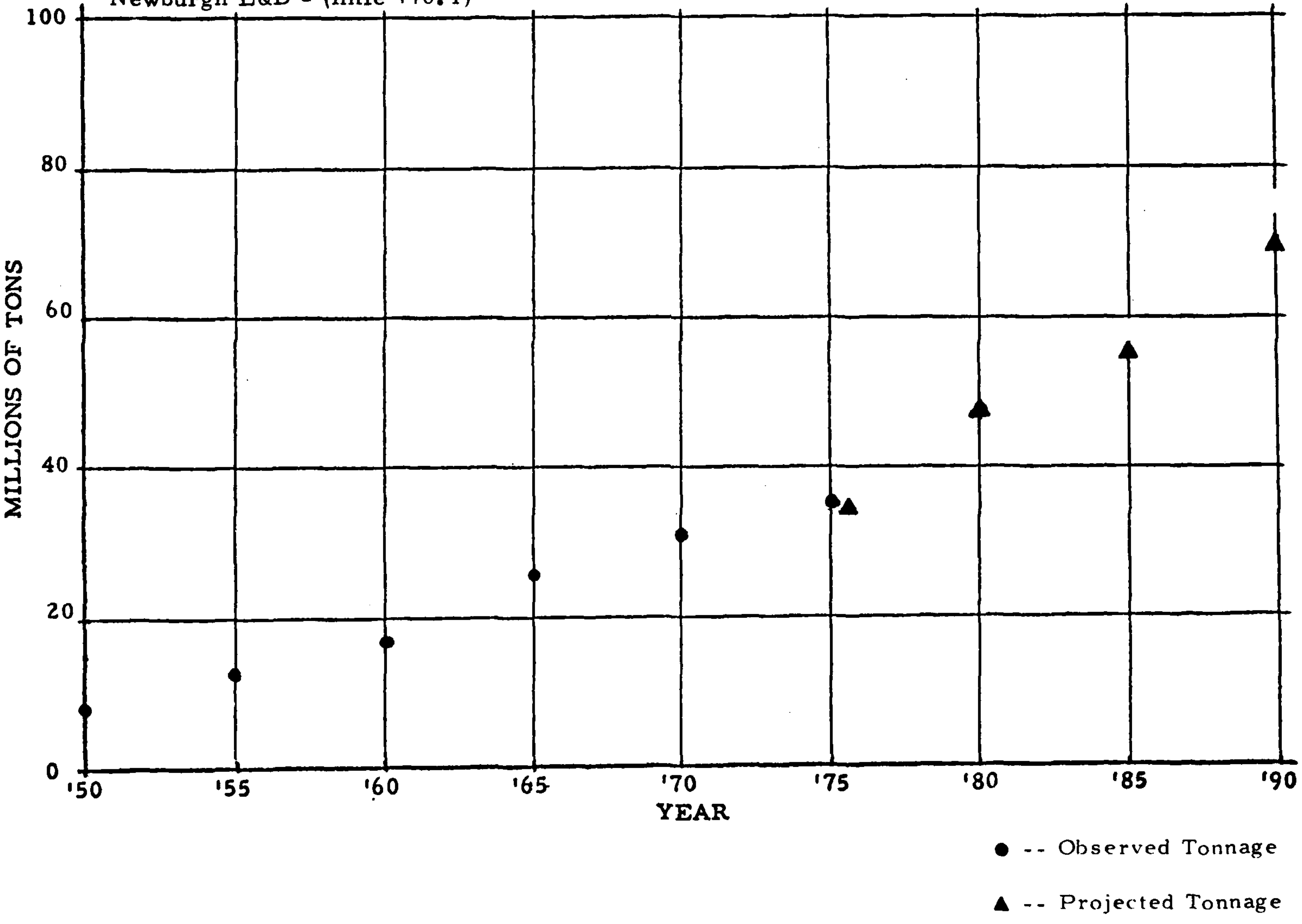
Newburgh L&D - (mile 776.1)



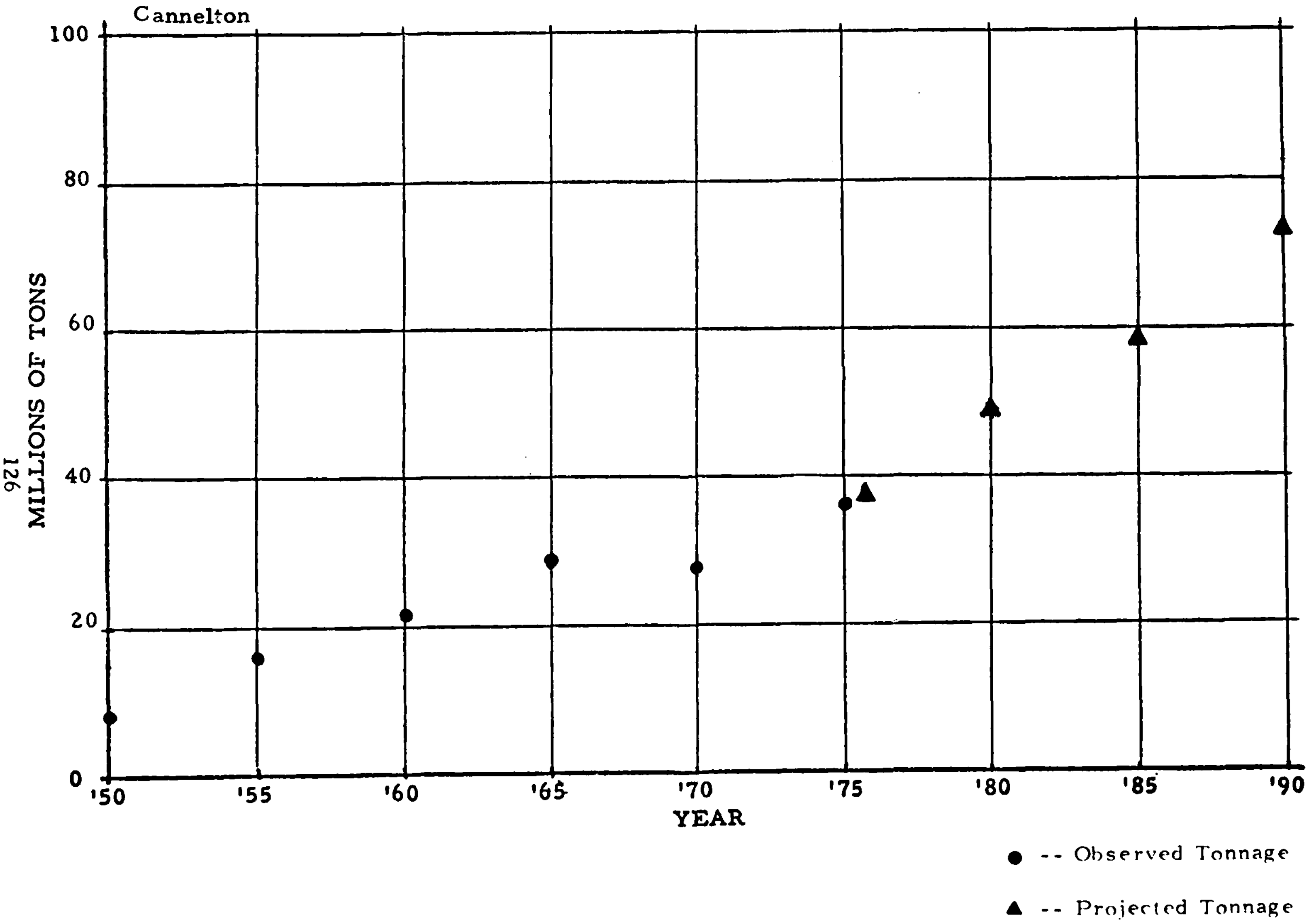
PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Ohio River Cannelton L&D (mile 720.7)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	18,228	14,600	3,628	20,530	16,112	4,418	25,573	19,604	5,969	31,480	23,463	8,017
2	6,895	6,398	497	8,553	7,894	659	10,652	9,854	798	13,034	12,087	947
4	589	199	390	683	285	398	827	483	344	1,068	784	284
5	1,503	26	1,477	928	11	917	1,364	12	1,352	1,955	15	1,940
6	4,340	3,699	641	4,950	4,121	829	6,219	5,168	1,051	7,558	6,257	1,301
7	2,289	2,078	211	4,336	3,895	441	5,488	4,816	672	6,751	5,779	972
8	3,039	1,642	1,397	4,343	2,371	1,972	5,063	2,815	2,248	5,892	3,347	2,545
9	2,831	2,393	438	3,487	2,927	560	4,376	3,739	637	5,393	4,680	713
3	193	193	0	0	0	0	0	0	0	0	0	0
Total	39,907	31,228	8,679	47,810	37,616	10,194	59,562	46,491	13,071	73,131	56,412	16,719

Base Year Assignment** = 38,020

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.


Cannelton
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▲ -- Projected Tonnage

PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Ohio River McAlpine L&D (mile 604.4)

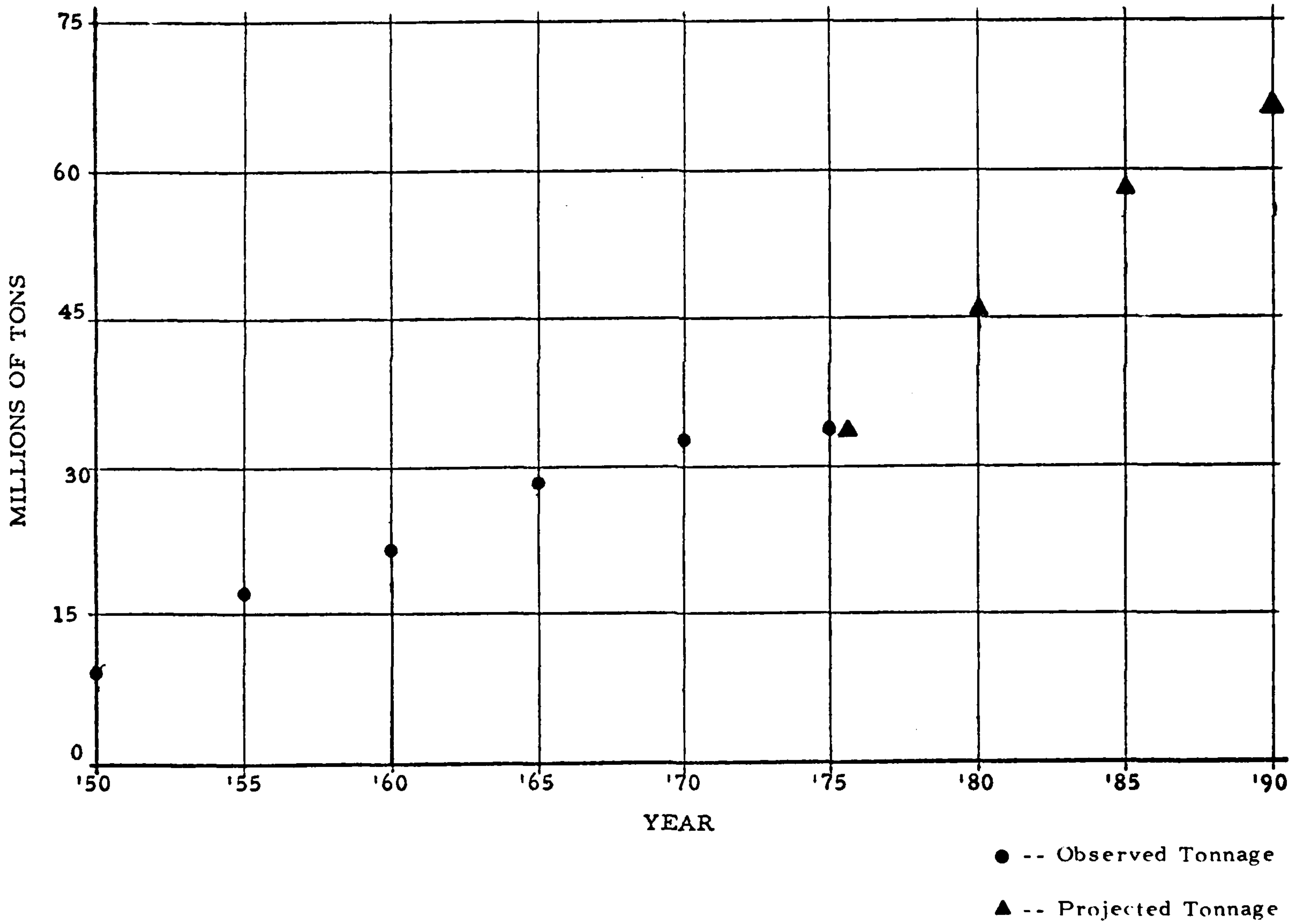
Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	16,579	12,953	3,626	19,108	14,692	4,416	24,188	18,222	5,966	30,541	22,527	8,014
2	6,576	4,980	1,596	8,375	6,296	2,079	10,469	7,861	2,608	12,853	9,650	3,203
4	229	227	2	324	324	0	528	528	0	839	839	0
5	1,503	26	1,477	928	11	917	1,364	12	1,352	1,955	15	1,940
6	4,150	3,491	659	4,762	3,931	831	5,971	4,927	1,044	7,237	5,971	1,266
7	2,290	2,079	211	4,336	3,895	441	5,488	4,816	672	6,751	5,779	972
8	3,039	1,642	1,397	4,345	2,373	1,972	5,065	2,817	2,248	5,895	3,350	2,545
9	2,649	2,269	380	3,309	2,846	463	4,130	3,637	493	5,037	4,532	505
3	193	193	0	0	0	0	0	0	0	0	0	0
Total	37,208	27,860	9,348	45,487	34,368	11,119	57,203	42,820	14,383	71,108	52,663	18,445

Base Year Assignment** = 37,232

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

McAlpine



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Ohio River Markland L&D (mile 531.5)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	9,744	7,466	2,278	10,639	8,082	2,557	12,887	9,757	3,130	15,515	11,813	3,702
2	6,332	4,554	1,778	7,861	5,490	2,371	9,861	6,872	2,989	12,137	8,455	3,682
4	1,410	1,398	12	2,133	2,121	12	2,987	2,973	14	4,123	4,105	18
5	1,377	6	1,371	906	2	904	1,329	2	1,327	1,893	2	1,891
6	4,079	3,426	653	4,657	3,826	831	5,832	4,790	1,042	7,055	5,790	1,265
7	2,144	1,933	211	3,898	3,457	441	4,951	4,279	672	6,113	5,141	972
8	3,239	1,620	1,619	4,639	2,339	2,300	5,418	2,780	2,638	6,322	3,313	3,009
9	2,587	2,200	387	3,159	2,730	429	3,939	3,488	451	4,847	4,383	464
3	193	193	0	0	0	0	0	0	0	0	0	0
Total	31,105	22,796	8,309	37,892	28,047	9,845	47,204	34,941	12,263	58,005	43,002	15,003

Base Year Assignment** = 29,379

*Thousands of tons.

***Commodity groups 5 and 6 use 1975 as base year; others use 1976.*

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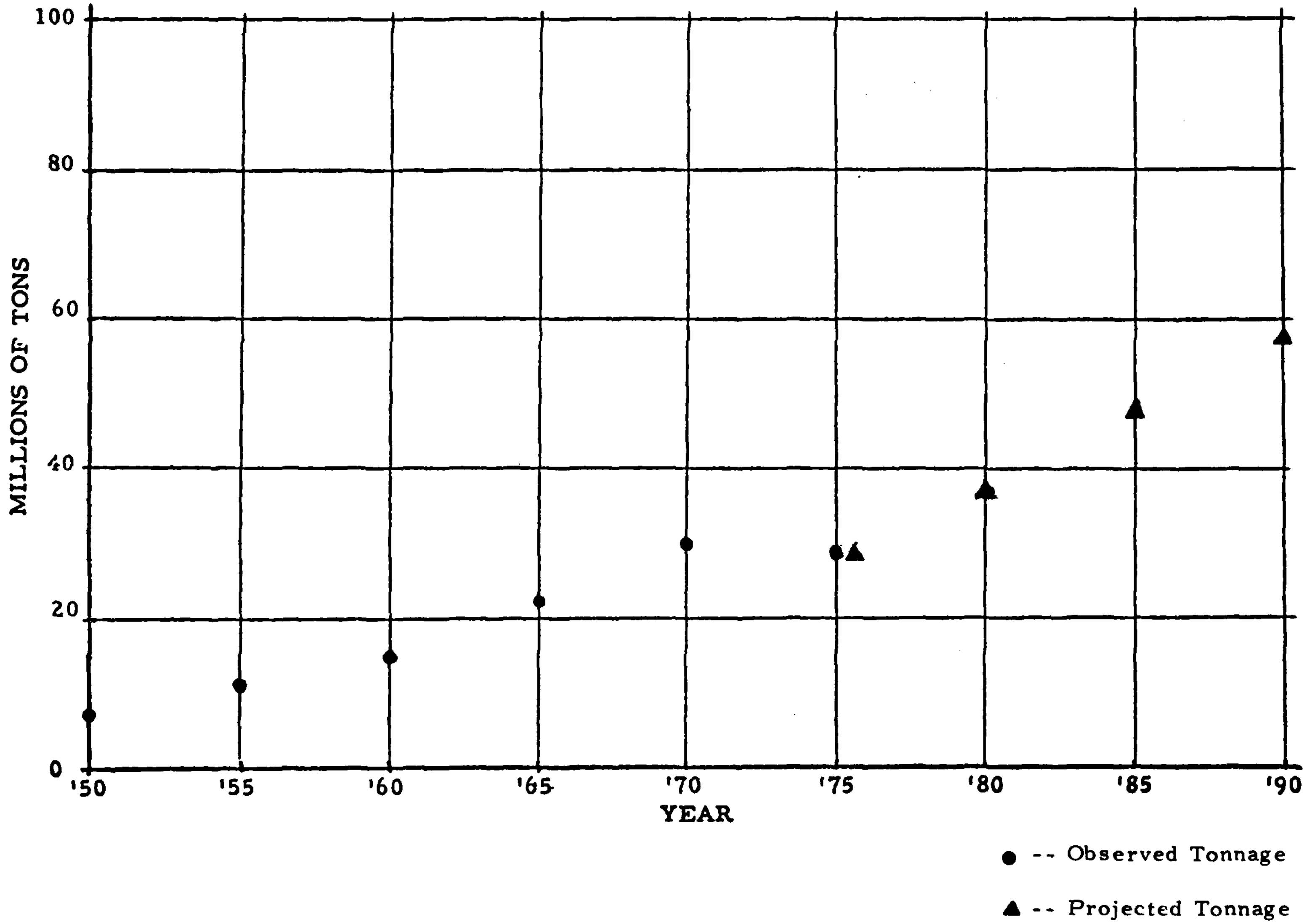
Markland



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Ohio River Meldahl L&D (mile 436.2)

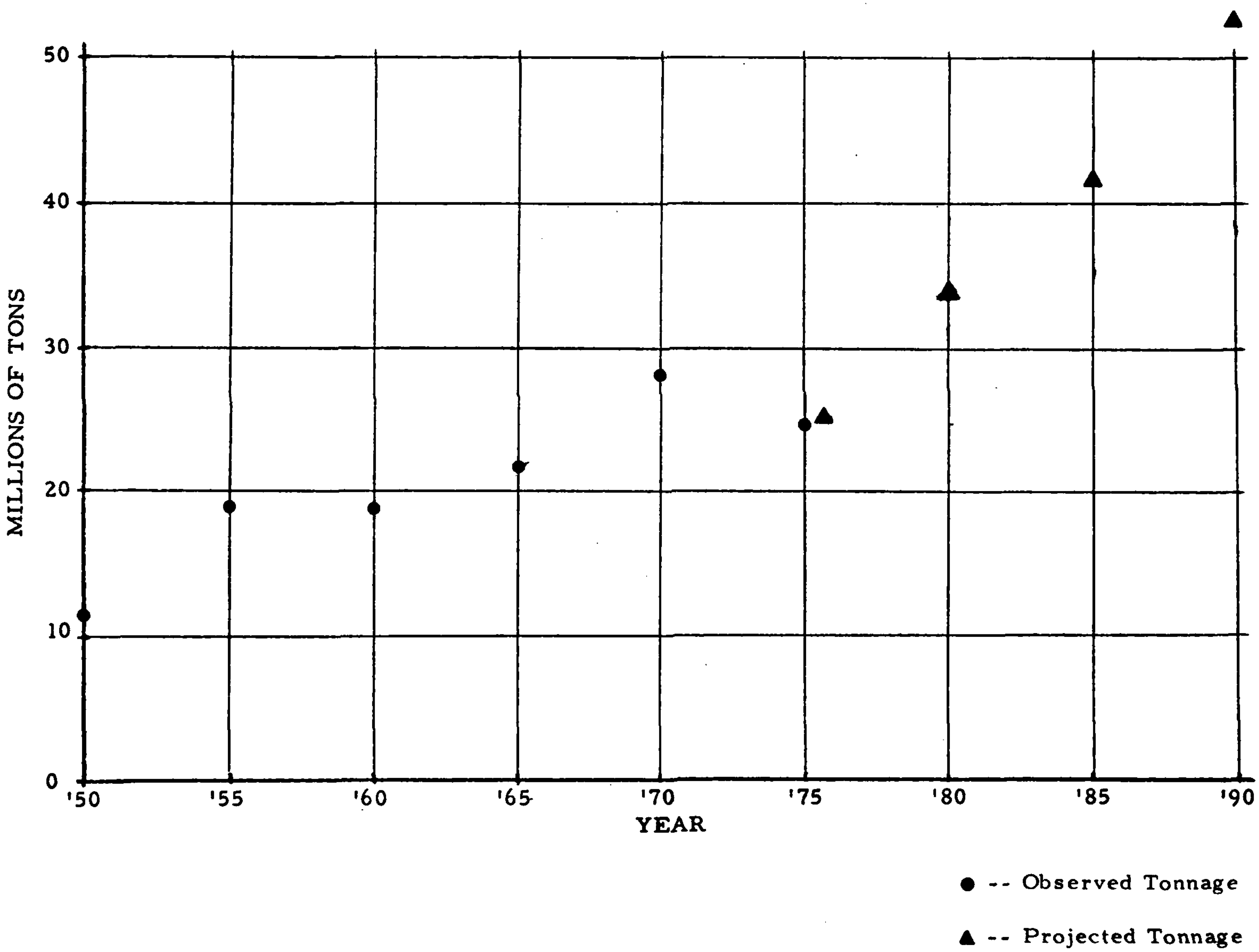
Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	9,350	3,940	5,410	10,613	4,486	6,127	13,307	5,703	7,604	16,603	7,358	9,245
2	6,214	4,393	1,821	7,771	5,311	2,460	9,848	6,724	3,124	12,272	8,382	3,890
4	2,176	2,174	2	2,830	2,830	0	3,241	3,241	0	3,590	3,590	0
5	8	3	5	1	1	0	1	1	0	1	1	0
6	3,242	2,517	725	3,968	3,000	968	4,947	3,709	1,238	6,898	4,422	2,476
7	1,573	1,362	211	2,828	2,387	441	3,578	2,906	672	4,405	3,433	972
8	3,072	1,302	1,770	4,376	1,852	2,524	5,081	2,186	2,895	5,933	2,619	3,314
9	1,851	1,521	330	2,201	1,826	375	2,766	2,367	399	3,454	3,034	420
3	193	193	0	0	0	0	0	0	0	0	0	0
Total	27,679	17,405	10,274	34,588	21,693	12,895	42,769	26,837	15,932	53,156	32,839	20,317

Base Year Assignment** = 26,663

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Meldahl



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

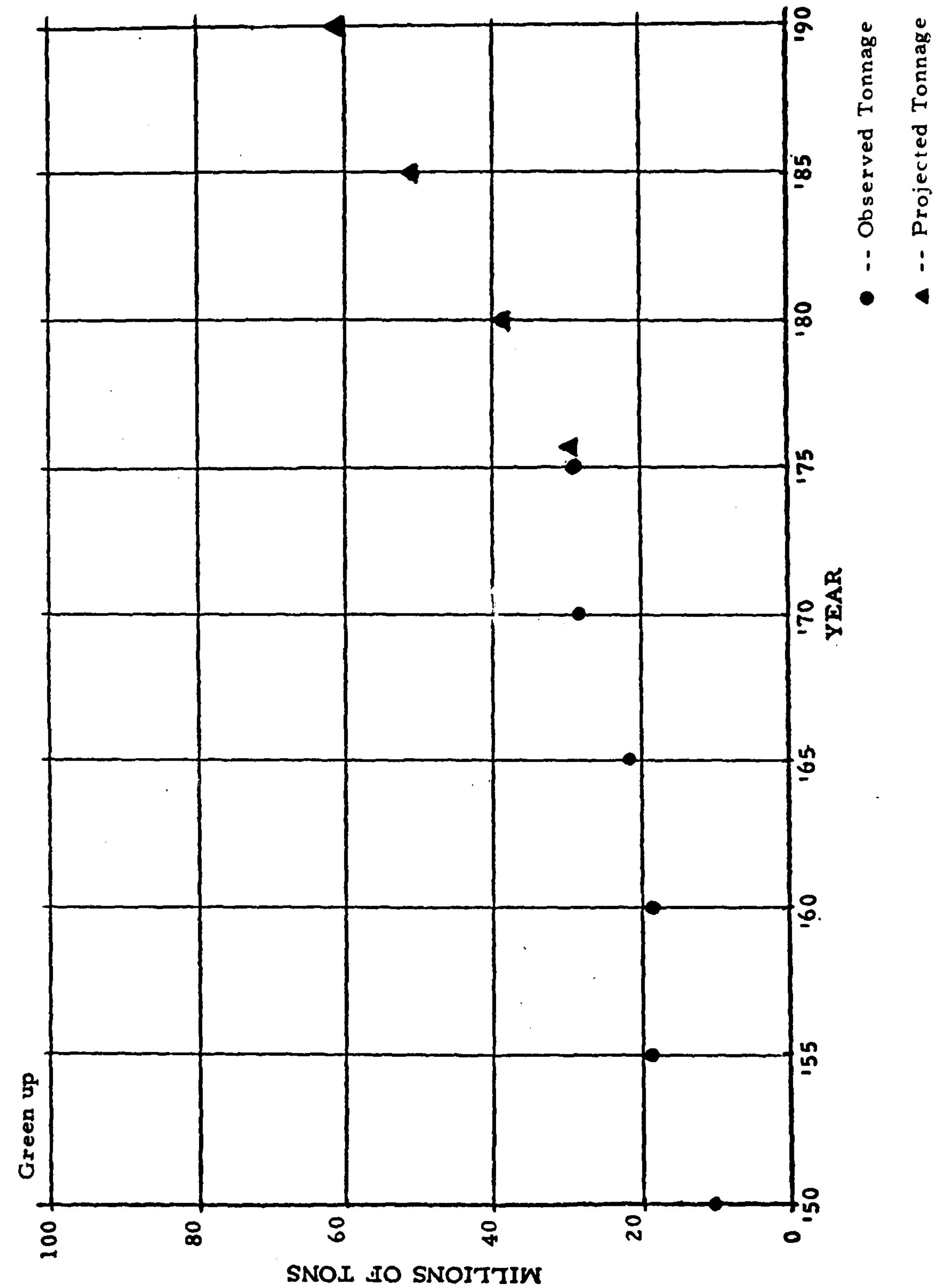
Ohio River Greenup L&D (mile 341.0)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	13,958	3,865	10,093	16,228	4,246	11,982	22,277	5,545	16,732	26,962	7,136	19,826
2	6,135	4,303	1,832	7,667	5,192	2,475	9,713	6,571	3,142	12,104	8,191	3,913
4	1,839	1,837	2	2,409	2,409	0	2,784	2,784	0	3,108	3,108	0
5	6	1	5	0	0	0	0	0	0	0	0	0
6	3,246	2,521	725	3,962	2,994	968	4,940	3,702	1,238	5,950	4,414	1,536
7	1,456	1,245	211	2,637	2,196	441	3,351	2,680	671	4,150	3,178	972
8	2,970	1,193	1,777	4,193	1,661	2,532	4,829	1,919	2,910	5,584	2,247	3,337
9	1,852	1,520	332	2,187	1,811	376	2,747	2,347	400	3,431	3,010	421
3	193	193	0	0	0	0	0	0	0	0	0	0
Total	31,655	16,678	14,977	39,283	20,509	18,774	50,641	25,548	25,093	61,289	31,284	30,005

Base Year Assignment** = 30,629

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79


Green up
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PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Ohio River Gallipolis L&D (mile 279.2)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	19,227	13,609	5,618	22,363	15,835	6,528	28,946	20,518	8,428	37,664	26,758	10,906
2	5,957	5,749	208	7,196	6,969	227	9,133	8,847	286	11,370	11,016	354
4	2,040	1,562	478	2,728	2,044	684	3,233	2,374	859	3,755	2,681	1,074
5	4	1	3	0	0	0	0	0	0	0	0	0
6	2,907	2,218	689	3,499	2,643	856	4,388	3,276	1,112	5,320	3,917	1,408
7	1,415	1,204	211	2,563	2,120	443	3,266	2,591	675	4,060	3,081	979
8	2,897	1,231	1,666	4,087	1,715	2,372	4,691	1,971	2,720	5,411	2,296	3,115
9	1,795	1,596	199	2,103	1,872	231	2,661	2,419	242	3,333	3,084	249
3	168	168	0	0	0	0	0	0	0	0	0	0
Total	36,410	27,338	9,072	44,539	33,198	11,341	56,318	41,996	14,322	70,913	52,833	18,080

Base Year Assignment** = 35,048

*Thousands of tons.

**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

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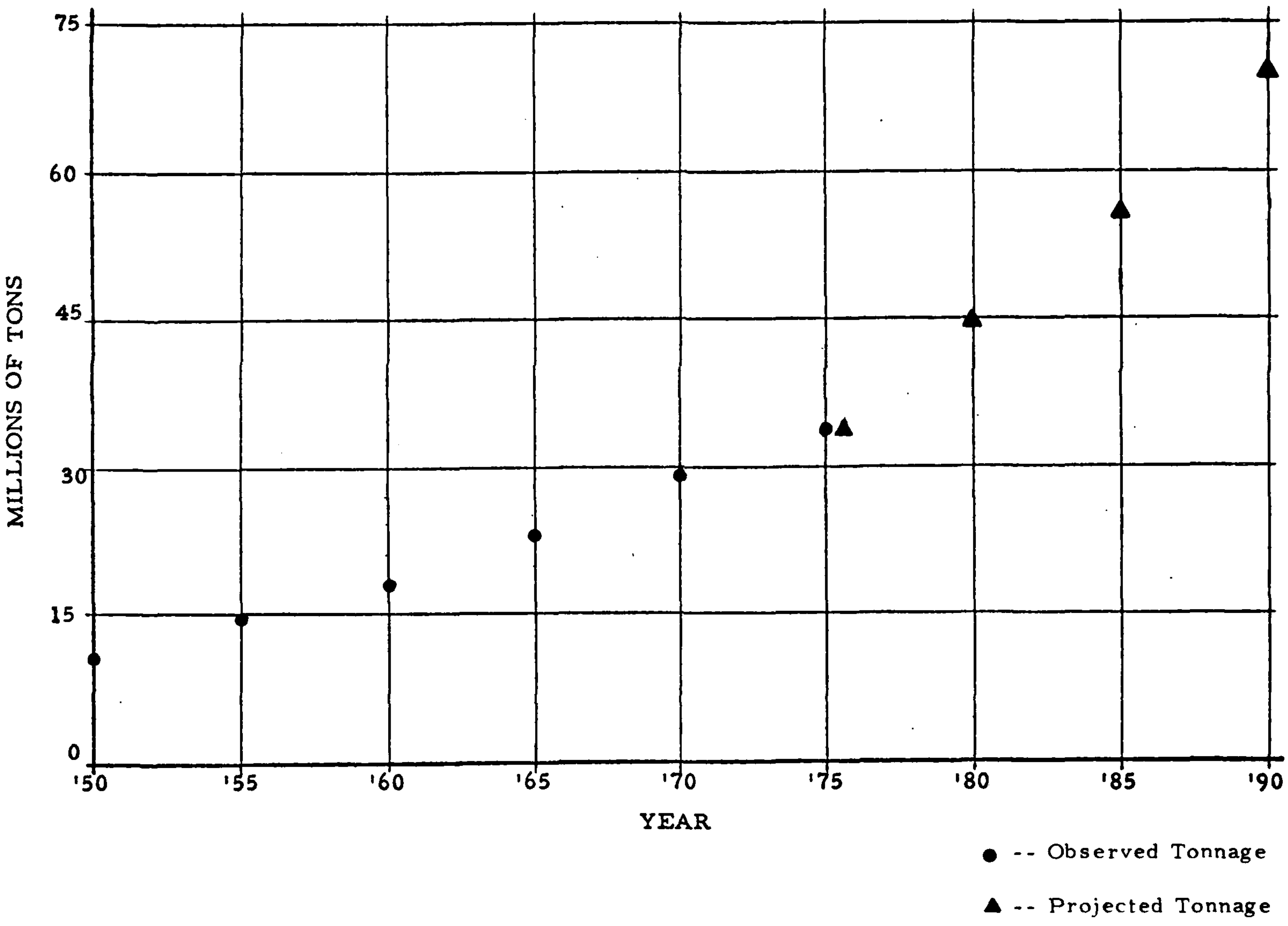
Gallipolis



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

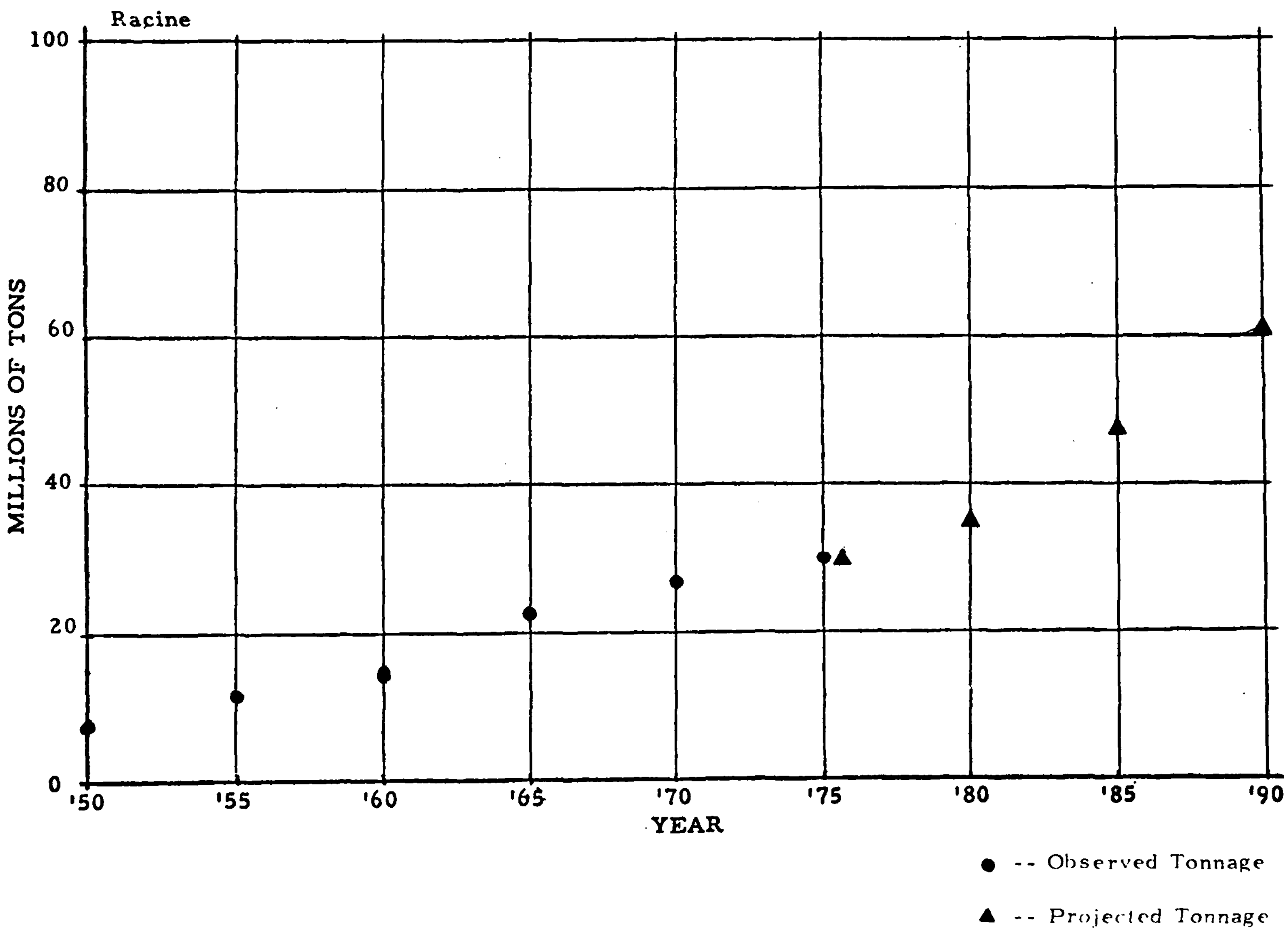
Ohio River Racine L&D (mile 237.5)

Com-modity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	14,843	8,556	6,287	14,384	8,291	6,093	22,714	11,601	11,113	29,498	14,282	15,216
2	4,807	4,640	167	5,654	5,484	170	7,177	6,963	214	8,930	8,669	261
4	1,967	359	1,608	2,612	342	2,270	3,144	311	2,833	3,864	266	3,598
5	4	1	3	0	0	0	0	0	0	0	0	0
6	2,195	1,356	839	4,323	1,612	2,711	5,459	2,018	3,441	6,674	2,442	4,232
7	1,247	1,066	181	2,324	1,923	401	3,036	2,384	652	3,854	2,869	985
8	2,921	1,258	1,663	4,120	1,751	2,369	4,730	2,010	2,720	5,463	2,342	3,121
9	1,687	1,409	278	1,899	1,593	306	2,388	2,066	322	2,971	2,647	324
3	168	168	0	0	0	0	0	0	0	0	0	0
Total	29,839	18,813	11,026	35,316	20,996	14,320	48,648	27,353	21,295	61,254	33,517	27,737

Base Year Assignment** = 30,147

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79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PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Ohio River Belleville L&D (mile 203.9)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	14,842	8,556	6,286	17,444	9,442	8,002	22,711	11,601	11,110	29,495	14,282	15,213
2	4,807	4,640	167	5,654	5,484	170	7,177	6,963	214	8,930	8,669	261
4	584	412	172	687	382	305	854	333	521	255	276	979
5	4	1	3	0	0	0	0	0	0	0	0	0
6	2,195	1,356	839	4,323	1,612	2,711	3,459	2,018	3,441	6,674	2,442	4,232
7	1,247	1,066	181	2,324	1,923	401	3,036	2,384	652	3,854	2,869	985
8	2,920	1,253	1,667	4,118	1,742	2,376	4,722	1,992	2,730	5,436	2,305	3,131
9	1,659	1,381	278	1,856	1,550	306	2,310	1,988	322	2,831	2,507	324
3	168	168	0	0	0	0	0	0	0	0	0	0
Total	28,426	18,833	9,593	36,406	22,135	14,271	46,269	27,279	18,990	58,475	33,350	25,125

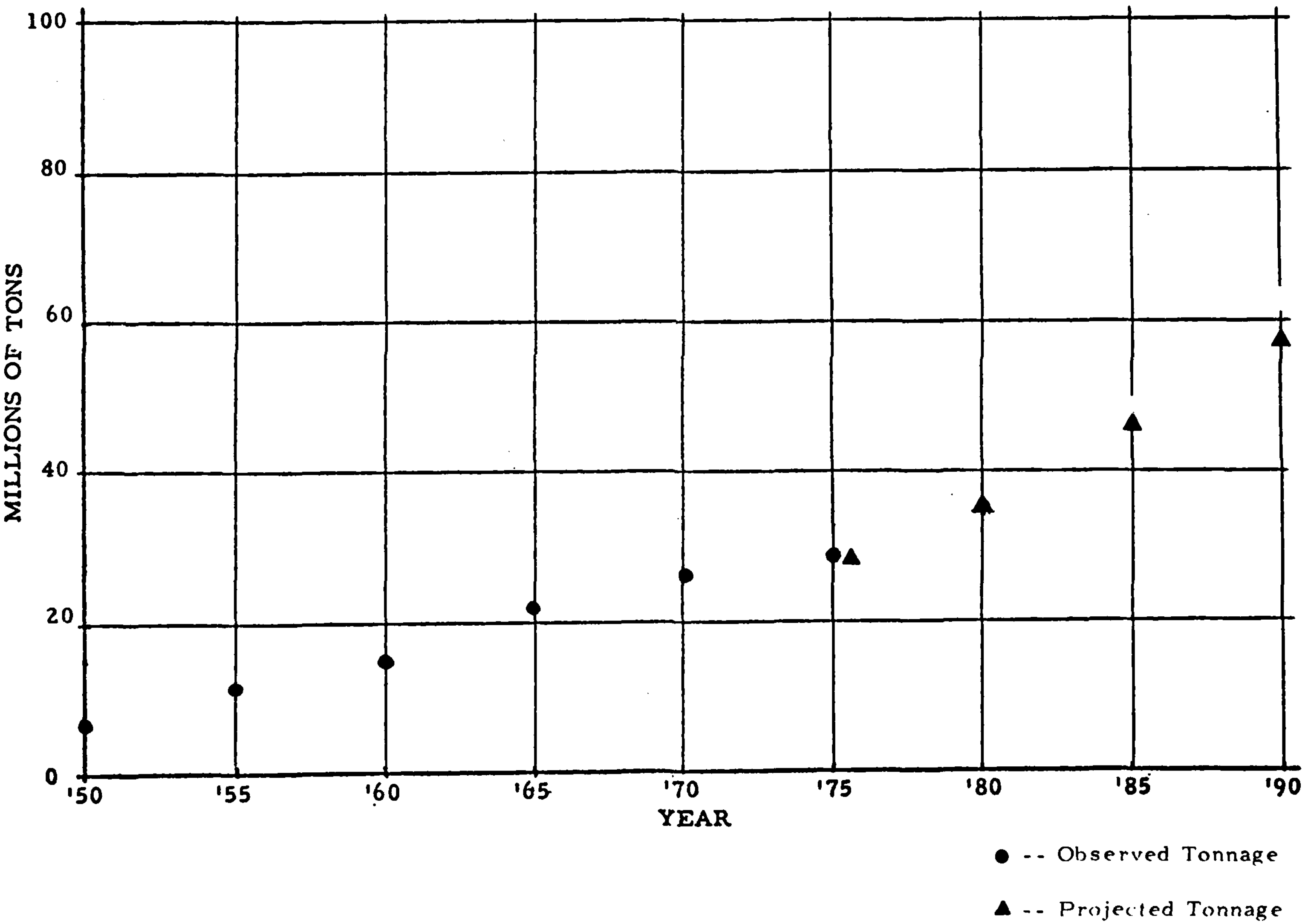
Base Year Assignment** = 28,735

*Thousands of tons.

**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Belleville



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Ohio River Willow Island L&D (mile 161.7)

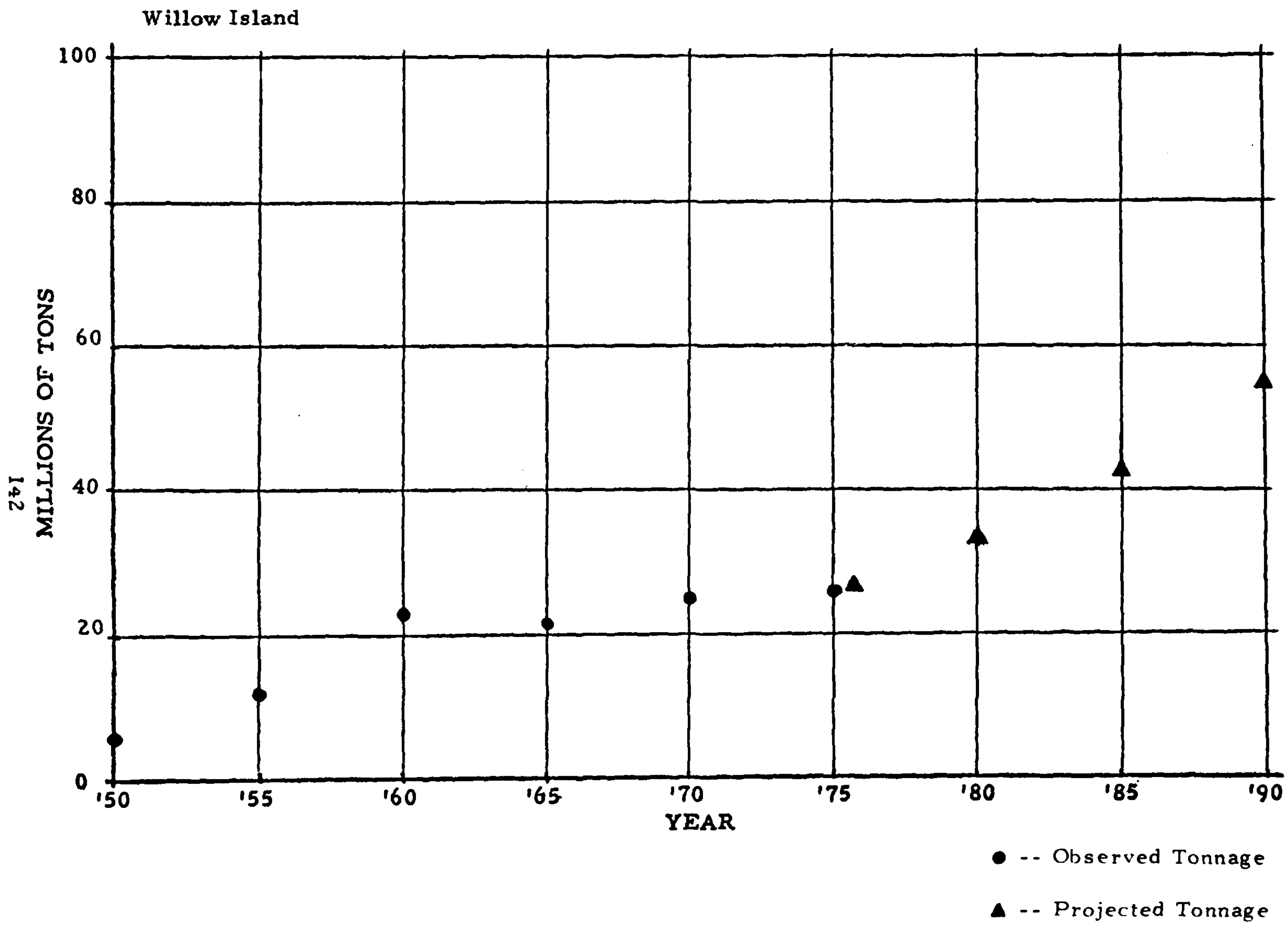
Commodity Group	Observed 1976 Traffic up + down	up	down	1980 up + down	up	down	1985 up + down	up	down	1990 up + down	up	down
1	14,215	8,441	5,774	16,605	9,339	7,266	21,488	11,508	9,980	27,698	14,189	13,509
2	4,238	4,071	167	4,915	4,745	170	6,276	6,022	214	7,856	7,595	261
4	1,098	366	732	1,490	343	1,147	1,945	298	1,647	2,717	243	2,474
5	3	1	2	0	0	0	0	0	0	0	0	0
6	1,956	1,122	834	4,048	1,350	2,698	5,117	1,691	3,426	6,265	2,049	4,216
7	939	767	172	1,733	1,342	391	2,308	1,645	663	3,082	1,991	1,091
8	2,830	1,189	1,641	3,939	1,618	2,321	4,414	1,772	2,642	4,919	1,923	2,996
9	1,625	1,325	300	1,781	1,454	327	2,175	1,819	356	2,580	2,210	370
3	21	21	0	0	0	0	0	0	0	0	0	0
Total	26,925	17,303	9,622	34,511	20,191	14,320	43,723	24,795	18,928	55,117	30,200	24,917

Base Year Assignment** = 27,410

*Thousands of tons.

**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79



Willow Island
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PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Ohio River Hannibal L&D (mile 126.4)

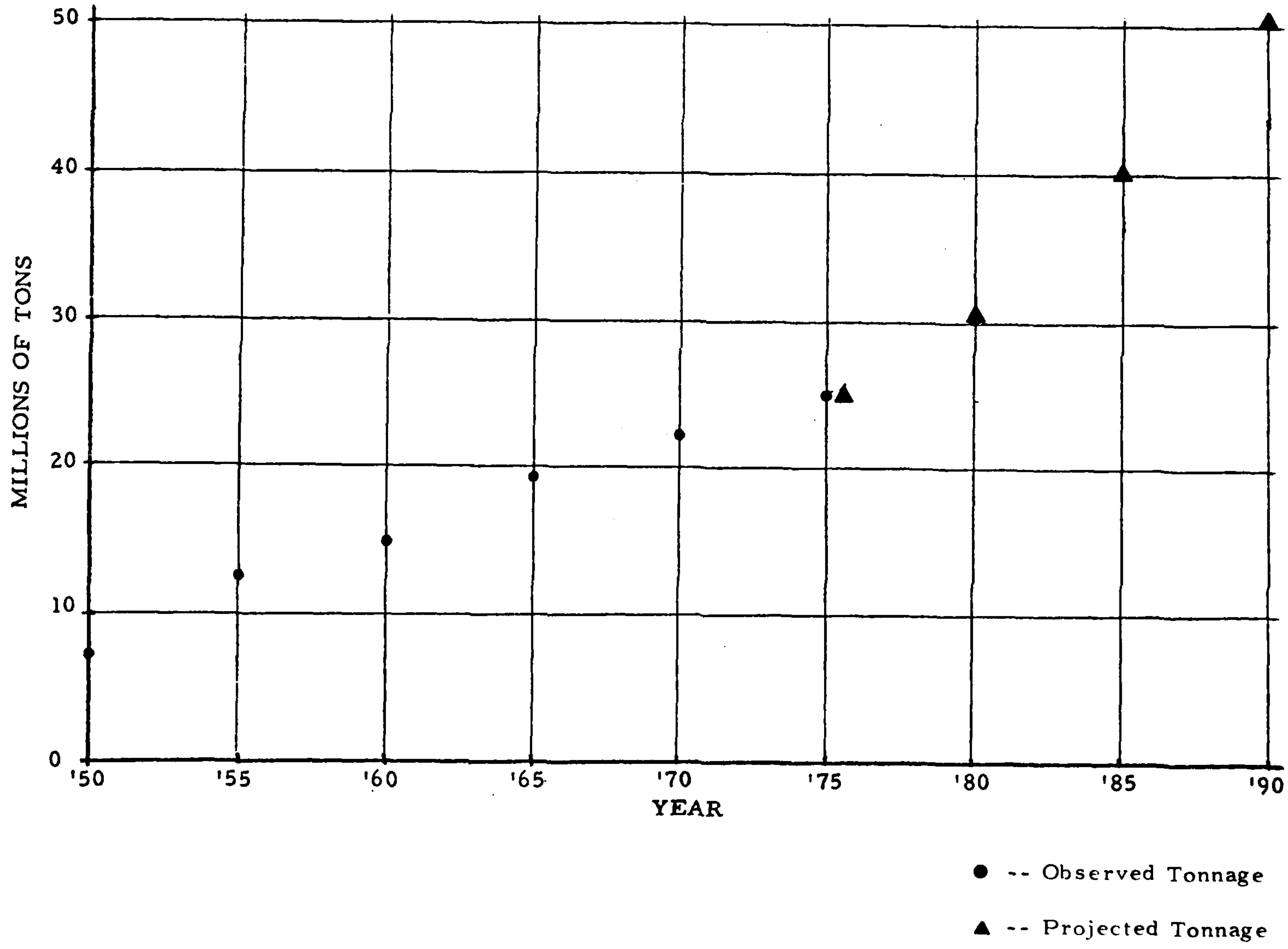
Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	14,205	8,431	5,774	16,596	9,330	7,266	21,473	11,493	9,980	27,692	14,183	13,509
2	4,213	4,061	152	4,870	4,731	139	6,216	6,047	169	7,774	7,579	195
4	602	578	24	824	806	18	1,152	1,141	11	1,656	1,650	6
5	2	1	1	0	0	0	0	0	0	0	0	0
6	1,671	1,096	575	2,042	1,319	723	2,615	1,652	963	3,250	2,000	1,250
7	933	761	172	1,721	1,330	391	2,293	1,630	663	3,062	1,971	1,091
8	2,814	1,185	1,629	3,913	1,609	2,304	4,378	1,756	2,622	4,871	1,897	2,974
9	1,686	1,324	362	1,856	1,449	407	2,288	1,806	482	2,744	2,187	557
3	21	21	0	0	0	0	0	0	0	0	0	0
Total	26,147	17,458	8,689	31,822	20,574	11,248	40,415	25,525	14,890	51,049	31,467	19,582

Base Year Assignment** = 25,450

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Hannibal

Revised 1/79



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Ohio River Pike Island L&D (mile 84.2)

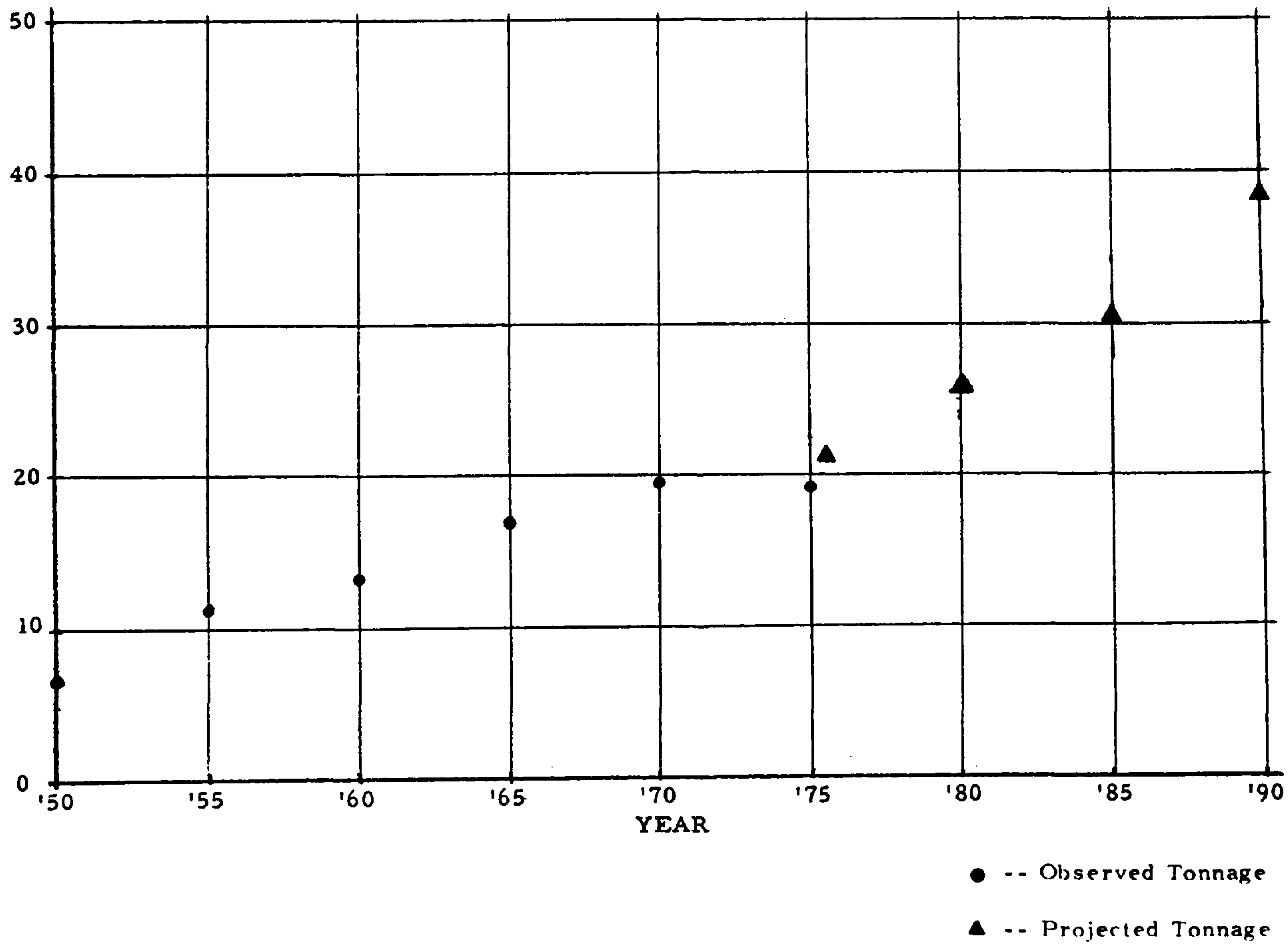
Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	11,725	9,704	2,021	12,536	10,256	2,280	14,817	12,010	2,807	17,352	13,983	3,369
2	4,134	3,999	135	4,780	4,657	123	6,104	5,953	151	7,634	7,461	173
4	303	99	204	266	57	209	229	59	170	184	66	118
5	3	1	2	0	0	0	0	0	0	0	0	0
6	1,254	731	523	1,568	895	673	2,030	1,127	903	2,554	1,375	1,179
7	908	736	172	1,653	1,262	391	2,211	1,548	663	2,968	1,877	1,091
8	2,769	1,179	1,590	3,848	1,600	2,248	4,306	1,747	2,559	4,787	1,886	2,901
9	1,648	1,286	362	1,855	1,449	406	2,287	1,806	481	2,740	2,184	556
3	21	21	0	0	0	0	0	0	0	0	0	0
Total	22,765	17,756	5,009	26,506	20,176	6,330	31,984	24,250	7,734	38,219	28,832	9,387

Base Year Assignment** = 22,164

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Pike Island



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Ohio River New Cumberland L&D (mile 54.4)

Com-modity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	10,057	8,253	1,804	10,725	8,905	1,820	12,677	10,619	2,058	14,897	12,599	2,298
2	3,832	3,688	144	4,389	4,268	121	5,605	5,456	149	7,014	6,840	174
4	1,648	1,647	1	1,952	1,951	1	2,078	2,076	2	2,174	2,172	2
5	1	1	0	0	0	0	0	0	0	0	0	0
6	1,234	716	518	1,566	884	682	2,026	1,115	911	2,552	1,363	1,189
7	857	685	172	1,559	1,168	391	2,098	1,435	663	2,839	1,748	1,091
8	2,284	1,126	1,158	3,160	1,526	1,634	3,518	1,661	1,857	3,885	1,783	2,102
9	1,598	1,272	326	1,768	1,402	366	2,166	1,738	428	2,583	2,096	487
3	8	8	0	0	0	0	0	0	0	0	0	0
Total	21,519	17,396	4,123	25,119	20,104	5,015	30,168	24,100	6,068	35,944	28,601	7,343

Base Year Assignment** = 20,925

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

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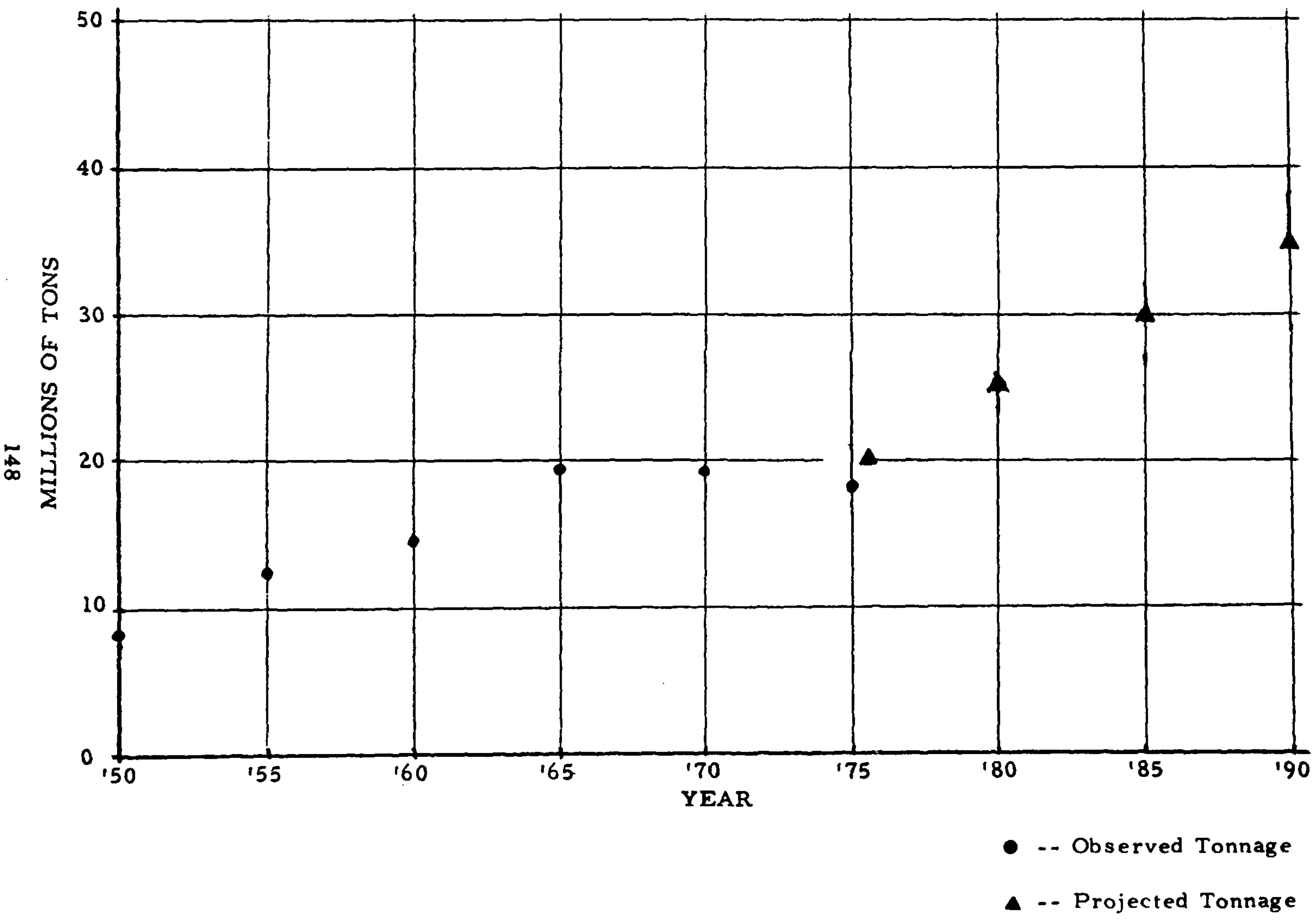
New Cumberland



Revised 1/79

PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Ohio River Montgomery L&D (mile 31.7)

Com-modity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	8,283	4,974	3,309	9,293	5,660	3,633	10,745	6,292	4,453	12,953	7,526	5,427
2	3,145	3,066	79	3,769	3,703	66	4,803	4,720	83	5,991	5,895	96
4	1,513	1,512	1	1,844	1,843	1	1,951	1,949	2	2,028	2,026	2
5	1	1	0	0	0	0	0	0	0	0	0	0
6	1,170	658	512	1,493	824	669	1,934	1,040	894	2,437	1,271	1,166
7	714	541	173	1,371	980	391	1,873	1,210	663	2,583	1,492	1,091
8	1,950	819	1,131	2,738	1,129	1,609	3,060	1,230	1,830	3,392	1,321	2,071
9	1,270	970	300	1,533	1,194	339	1,877	1,481	396	2,241	1,790	451
3	4	4	0	0	0	0	0	0	0	0	0	0
Total	18,050	12,545	5,505	22,041	15,333	6,708	26,243	17,922	8,321	31,625	21,321	10,304

Base Year Assignment** = 17,929

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

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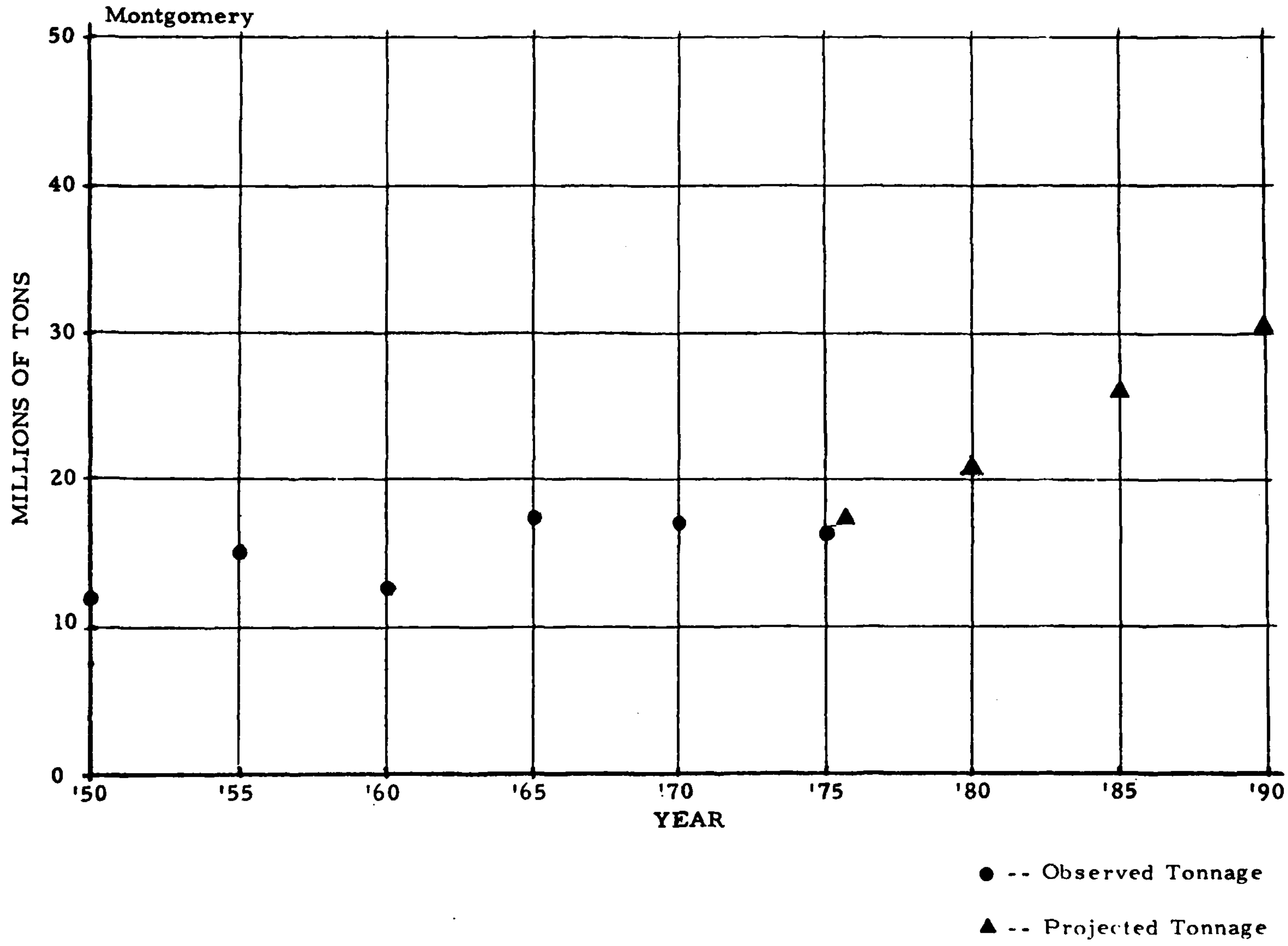

Montgomery
50
40
30
20
10
0
MILLIONS OF TONS
'50
'55
'60
'65
'70
'75
'80
'85
'90
YEAR
● -- Observed Tonnage
▲ -- Projected Tonnage

PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Ohio River-Dashields L&D (mile 13.3)

Com-modity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	12,839	4,698	8,141	13,730	5,002	8,728	16,290	5,927	10,363	19,229	7,076	12,153
2	2,865	2,830	35	3,424	3,408	16	4,367	4,344	23	5,449	5,423	26
4	1,329	1,328	1	1,610	1,609	1	1,699	1,697	2	1,763	1,761	2
5	0	0	0	0	0	0	0	0	0	0	0	0
6	701	405	296	1,000	525	475	1,294	662	632	1,623	806	817
7	686	513	173	1,321	930	391	1,815	1,152	663	2,515	1,424	1,091
8	1,474	712	762	2,046	975	1,071	2,279	1,061	1,218	2,522	1,144	1,378
9	1,105	840	265	1,319	1,026	293	1,618	1,276	342	1,937	1,545	392
3	3	3	0	0	0	0	0	0	0	0	0	0
Total	21,002	11,329	9,673	24,450	13,475	10,975	29,362	16,119	13,243	35,038	19,179	15,859

Base Year Assignment** = 20,968

*Thousands of tons.

**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

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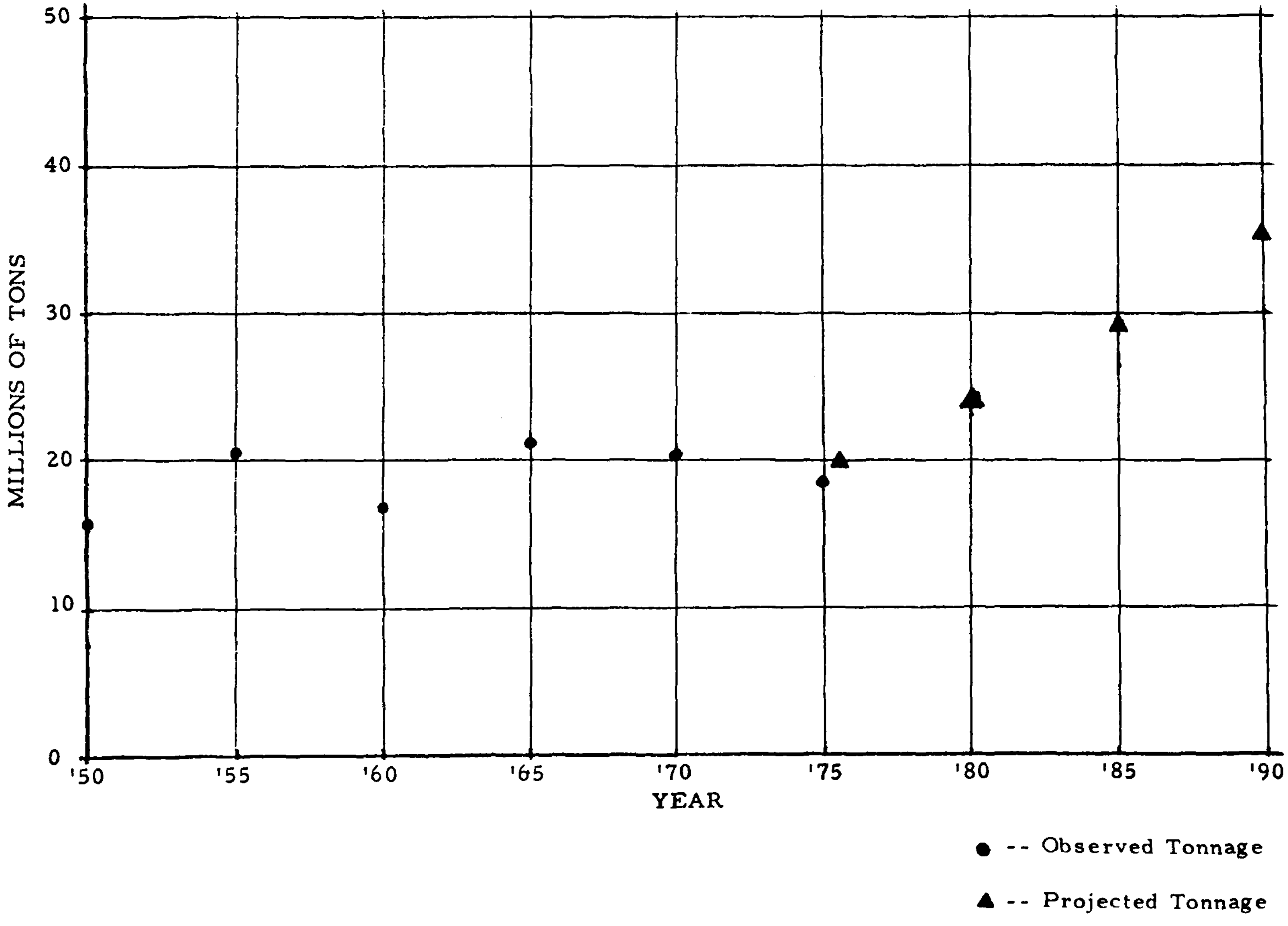
Dashields



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Ohio River-Emsworth L&D (mile 6.2)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	12,833	4,692	8,141	13,730	5,002	8,728	16,290	5,927	10,363	19,229	7,076	12,153
2	2,693	2,664	29	3,117	3,102	15	3,960	3,939	21	4,926	4,903	23
4	1,130	1,129	1	1,350	1,349	1	1,396	1,394	2	1,418	1,415	3
5	0	0	0	0	0	0	0	0	0	0	0	0
6	669	373	296	998	524	474	1,290	650	630	1,618	804	814
7	686	513	173	1,321	930	391	1,815	1,152	663	2,515	1,424	1,091
8	1,453	707	746	2,042	978	1,064	2,274	1,064	1,210	2,515	1,147	1,368
9	1,027	802	225	1,218	965	253	1,487	1,195	293	1,780	1,446	334
3	3	3	0	0	0	0	0	0	0	0	0	0
Total	20,494	10,883	9,611	23,776	12,850	10,926	28,513	15,331	13,182	34,001	18,215	15,786

Base Year Assignment** = 20,450

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

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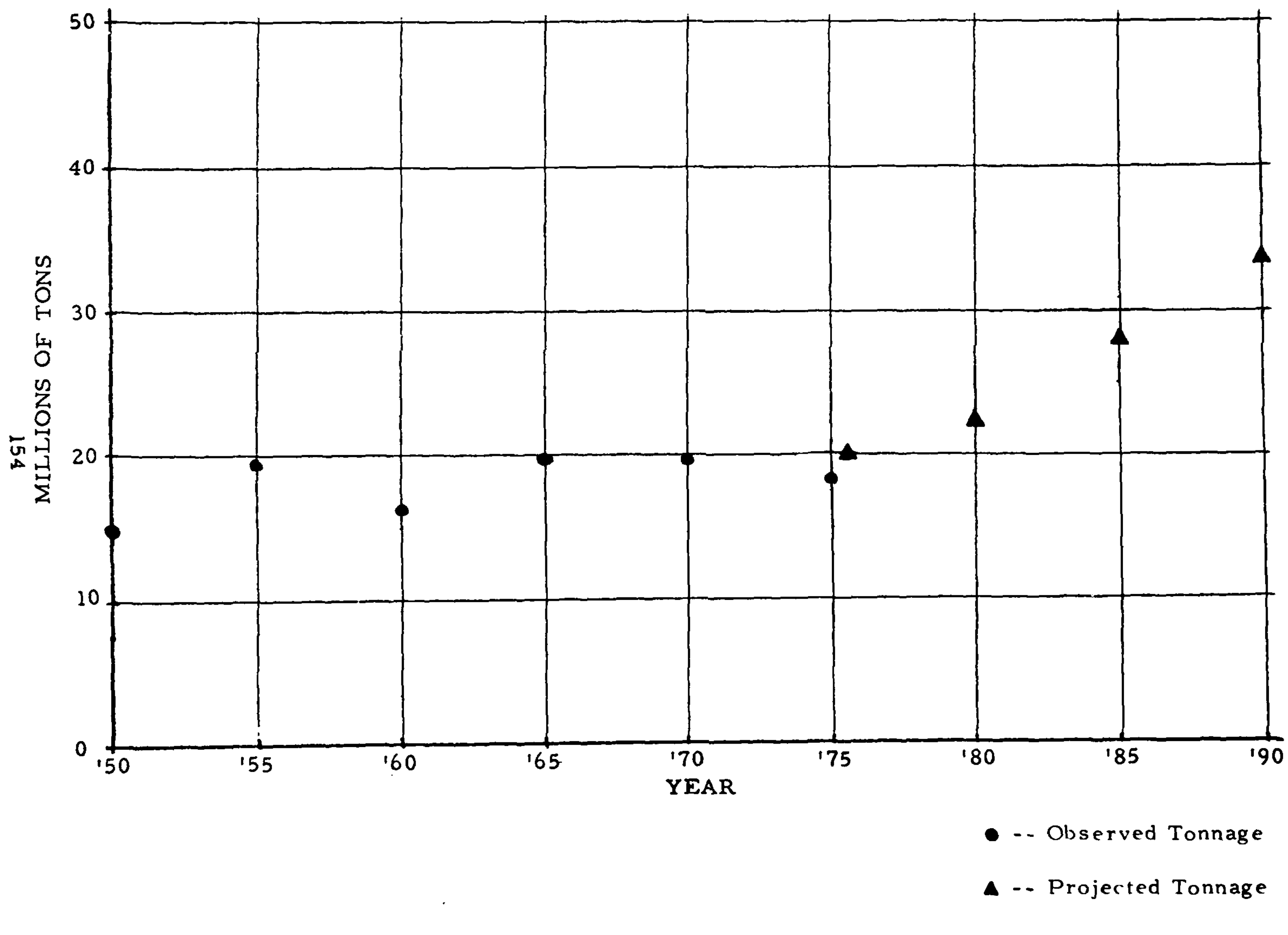
Emsworth



PROJECTED LOCK AND DAM TRAFFIC

MONONGAHELA RIVER

PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Monongahela L&D #2 (mile 11.2)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	15,772	4,688	11,084	16,852	5,107	11,745	19,934	6,170	13,764	23,399	7,500	15,899
2	1,487	1,476	11	1,724	1,716	8	2,173	2,161	12	2,684	2,672	12
4	1,143	555	588	1,487	710	777	1,692	796	896	1,892	879	1,013
5	0	0	0	0	0	0	0	0	0	0	0	0
6	385	22	363	560	30	530	753	42	711	972	51	921
7	403	241	162	849	471	378	1,252	613	639	1,867	818	1,049
8	745	204	541	1,010	243	767	1,132	263	869	1,263	282	981
9	333	247	86	382	288	94	467	356	111	556	427	129
3	0	0	0	0	0	0	0	0	0	0	0	0
Total	20,268	7,433	12,835	22,864	8,565	14,299	27,403	10,401	17,002	32,633	12,629	20,004

Base Year Assignment** = 20,199

*Thousands of tons.

**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

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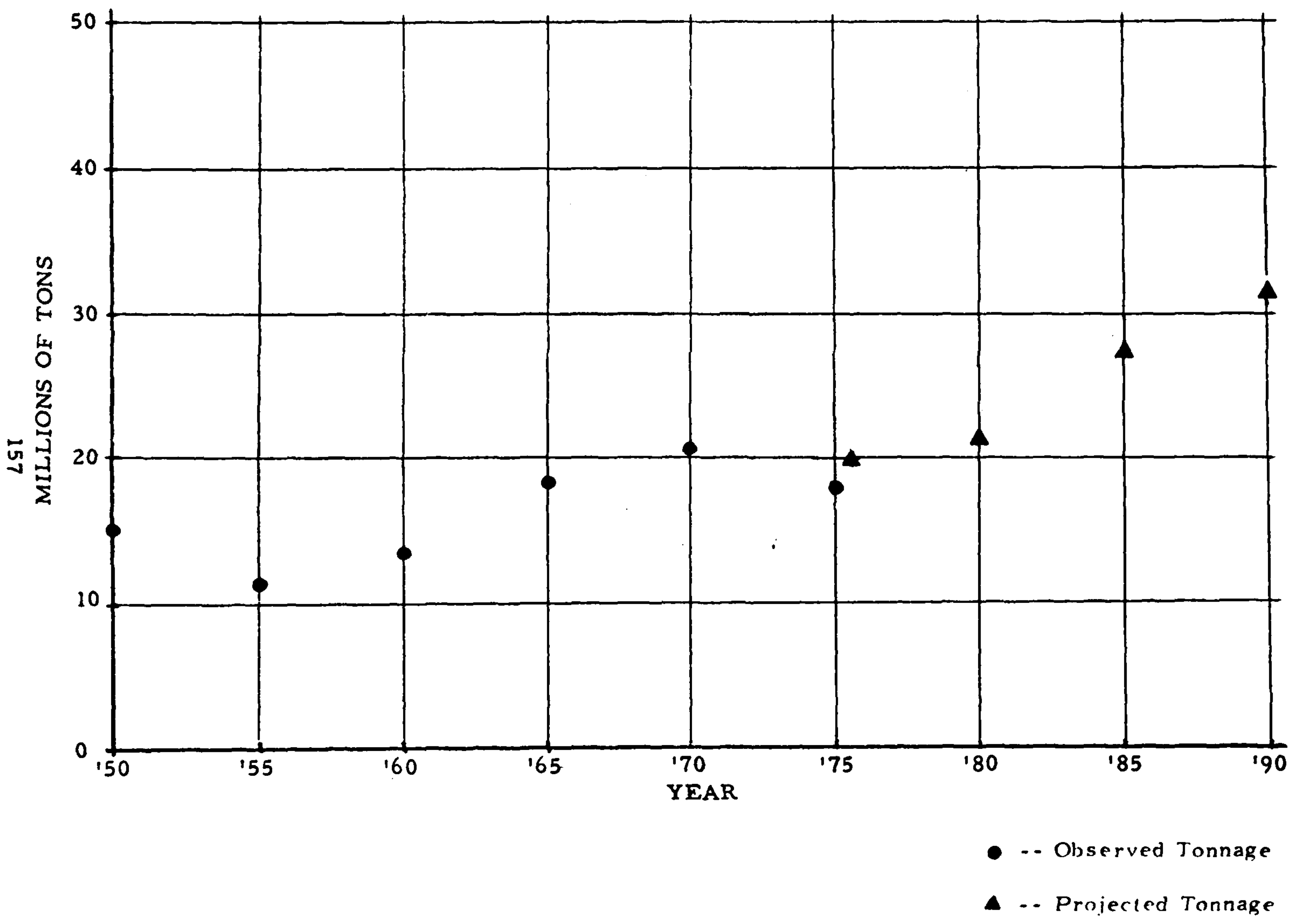
Monongahela L&D #2 - (mile 11.2)



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Monongahela L&D #3 (mile 23.8)

Commodity Group	Observed 1976 Traffic up + down	up	down	1980 up + down	up	down	1985 up + down	up	down	1990 up + down	up	down
1	18,042	1,160	16,882	19,412	1,438	17,974	23,088	1,928	21,160	26,955	2,537	24,418
2	1,257	1,235	22	1,442	1,425	17	1,809	1,788	21	2,228	2,203	25
4	935	347	588	1,231	454	777	1,412	516	896	1,589	576	1,013
5	0	0	0	0			0			0		
6	130	18	112	140	17	123	186	22	164	242	28	214
7	360	198	162	528	297	231	839	441	398	1,357	689	668
8	382	101	281	527	136	391	589	146	443	657	157	500
9	231	196	35	265	227	38	325	281	44	390	339	51
3	0	0	0	0	0	0	0	0	0	0	0	0
Total	21,337	3,255	18,082	23,545	3,994	19,551	28,248	5,122	23,126	33,418	6,529	26,889

Base Year Assignment** = 21,041

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

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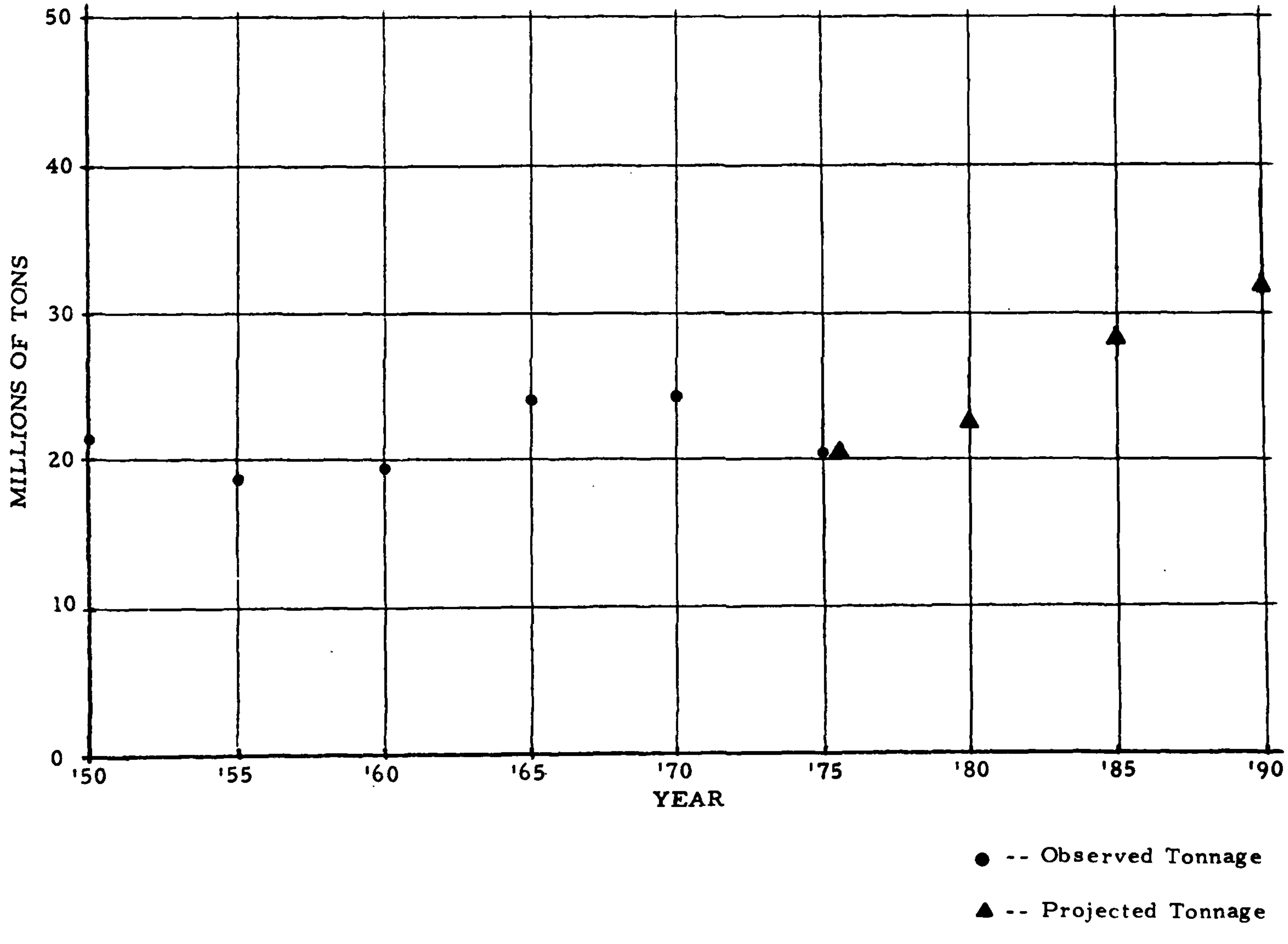
Monongahela L&D #3 - (mile 23.8)



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Monongahela L&D #4 (mile 41.5)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	16,082	815	15,267	17,253	1,044	16,209	20,373	1,420	18,953	23,597	1,874	21,723
2	462	461	1	547	547	0	667	667	0	802	802	0
4	892	306	586	1,182	406	776	1,361	467	894	1,539	528	1,011
5	0	0	0	0			0			0		
6	37	18	19	73	14	59	97	18	79	125	23	102
7	51	50	1	129	127	2	233	229	4	416	409	7
8	109	42	67	154	59	95	170	63	107	189	67	122
9	74	54	20	85	63	22	104	78	26	127	97	30
3	0	0	0	0	0	0	0	0	0	0	0	0
Total	17,707	1,746	15,961	19,423	2,260	17,163	23,005	2,942	20,063	26,795	3,800	22,995

Base Year Assignment** = 17,721

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

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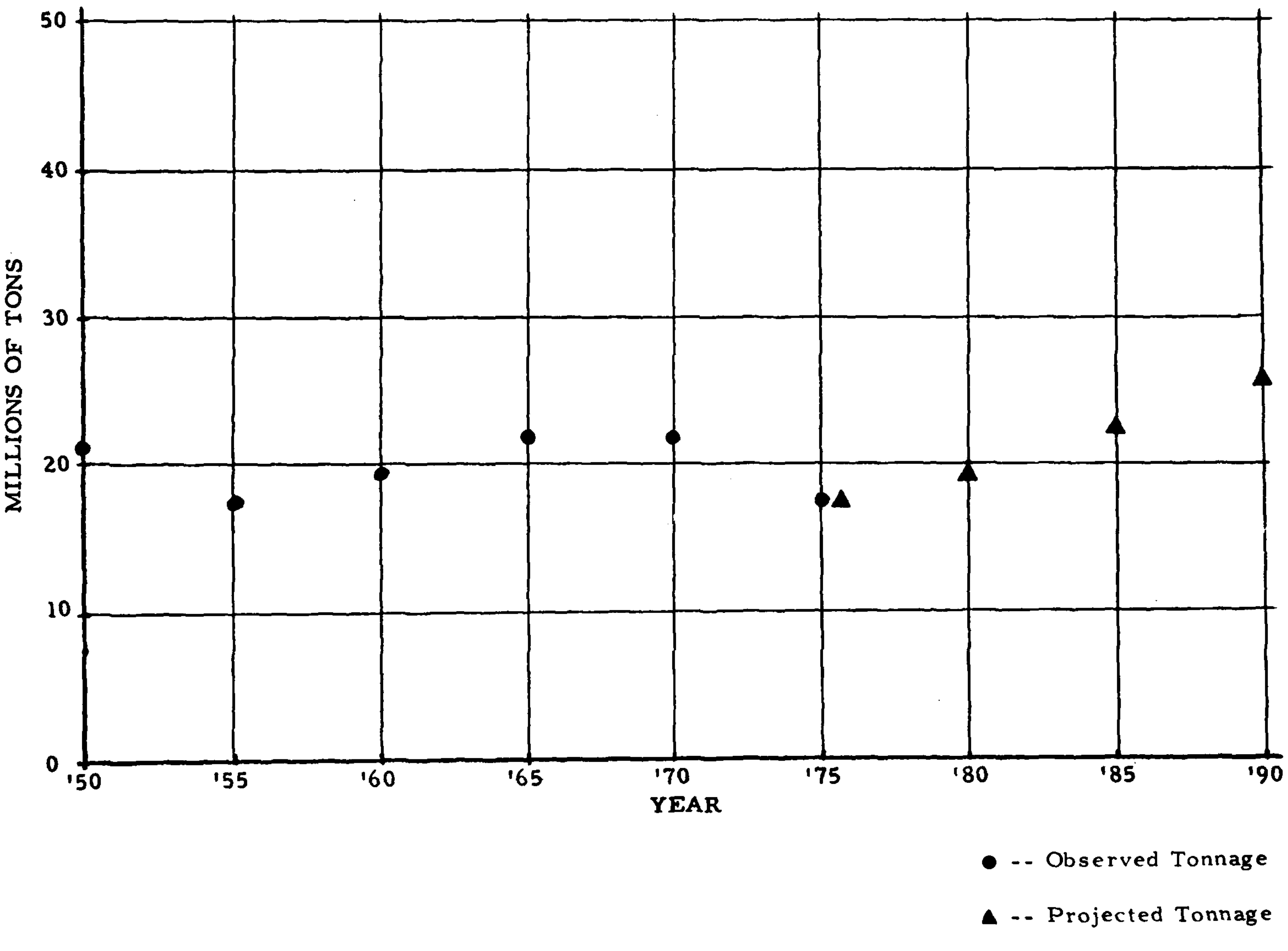
Monongahela L&D #4 - (mile 41.5)



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Monongahela Maxwell L&D (mile 61.2)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	16,103	1,304	14,799	17,347	1,691	15,656	20,586	2,340	18,246	24,005	3,158	20,847
2	343	343	0	414	414	0	499	499	0	590	590	0
4	591	4	587	782	5	777	900	5	895	1,017	5	1,012
5	0	0	0	0			0			0		
6	0	0	0	0			0			0		
7	47	47	0	121	121	0	222	222	0	401	401	0
8	0	0	0	0			0			0		
9	35	35	0	42	42	0	54	54	0	66	66	0
3	0	0	0	0	0	0	0	0	0	0	0	0
Total	17,119	1,733	15,386	18,706	2,273	16,433	22,261	3,120	19,141	26,079	4,220	21,859

Base Year Assignment** = 17,121

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

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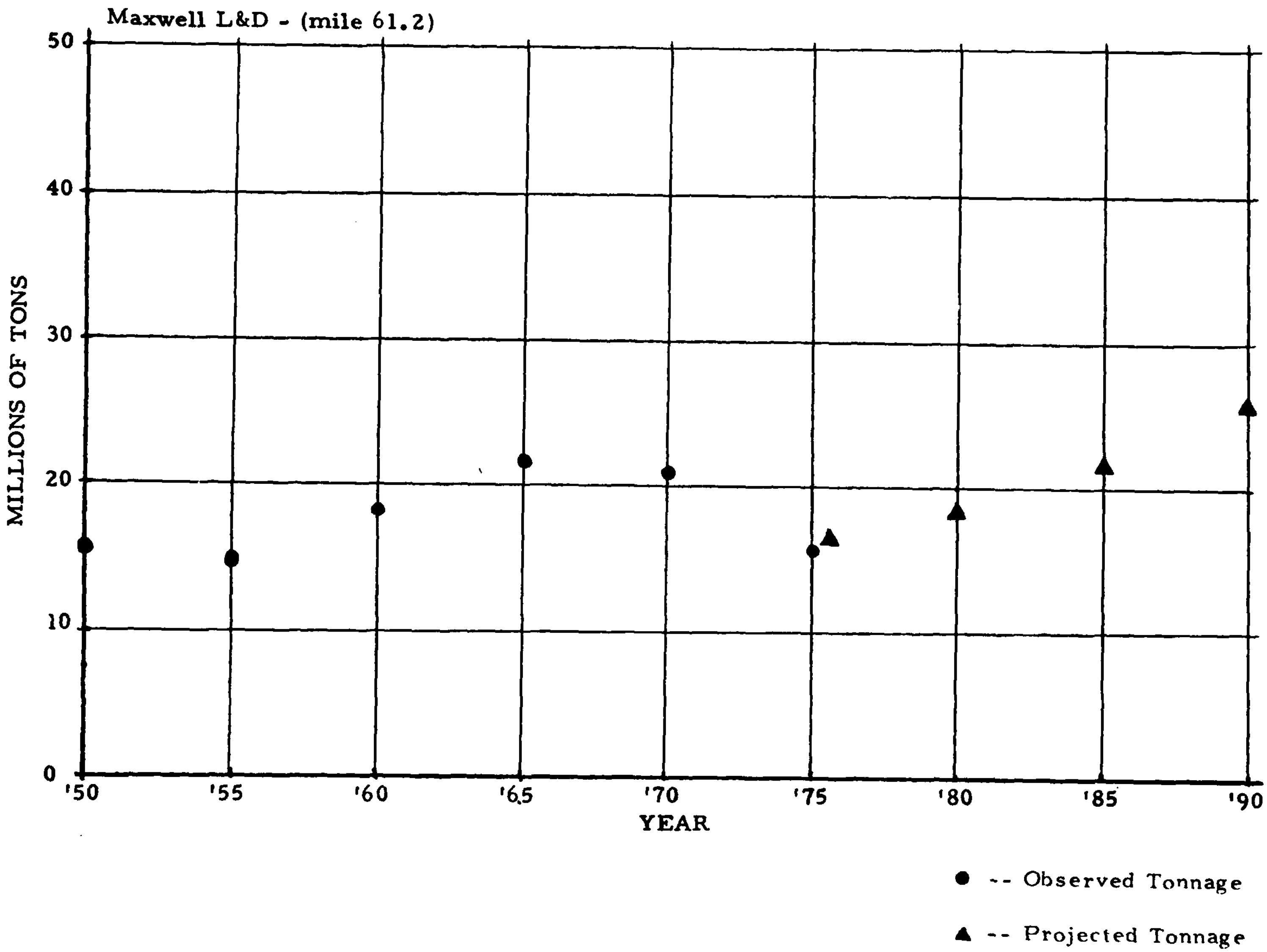

Maxwell L&D - (mile 61.2)
MILLIONS OF TONS
0
10
20
30
40
50
'50
'55
'60
'65
'70
'75
'80
'85
'90
YEAR
● -- Observed Tonnage
▲ -- Projected Tonnage

PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Monongahela L&D #7 (mile 85.0)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	6,049	142	5,907	6,480	146	6,334	7,695	160	7,535	9,058	164	8,894
2	343	343	0	414	414	0	499	499	0	590	590	0
4	591	4	587	782	5	777	901	5	896	1,018	5	1,013
5	0	0	0	0			0			0		
6	0	0	0	0			0			0		
7	47	47	0	121	121	0	222	222	0	401	401	0
8	0	0	0	0			0			0		
9	34	34	0	41	41	0	53	53	0	64	64	0
3	0	0	0	0	0	0	0	0	0	0	0	0
Total	7,064	570	6,494	7,838	727	7,111	9,370	939	8,431	11,131	1,224	9,907

Base Year Assignment** = 7,065

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

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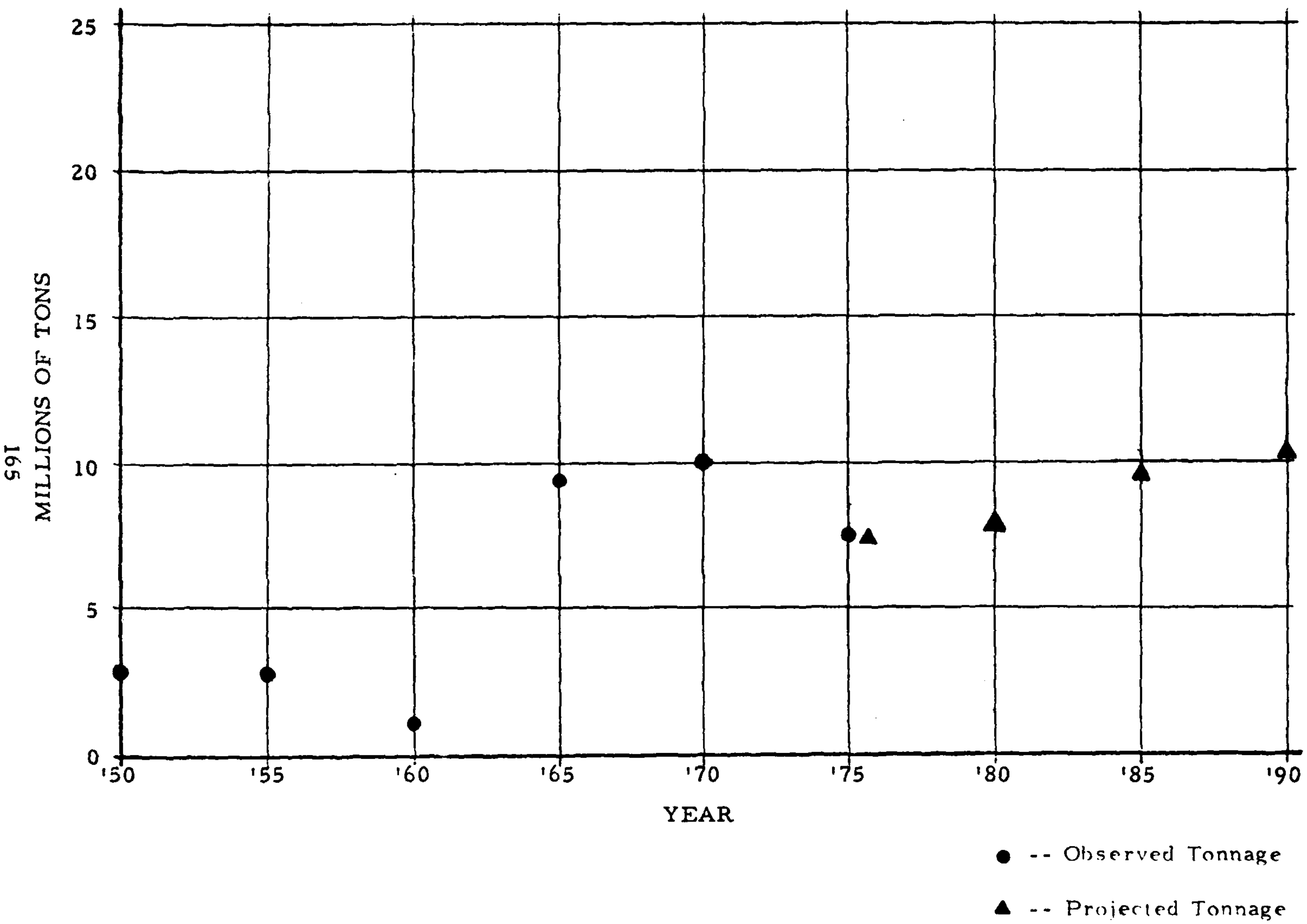
Monongahela L&D #7 - (mile 85.0)



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Monongahela L&D #8 (mile 90.8)

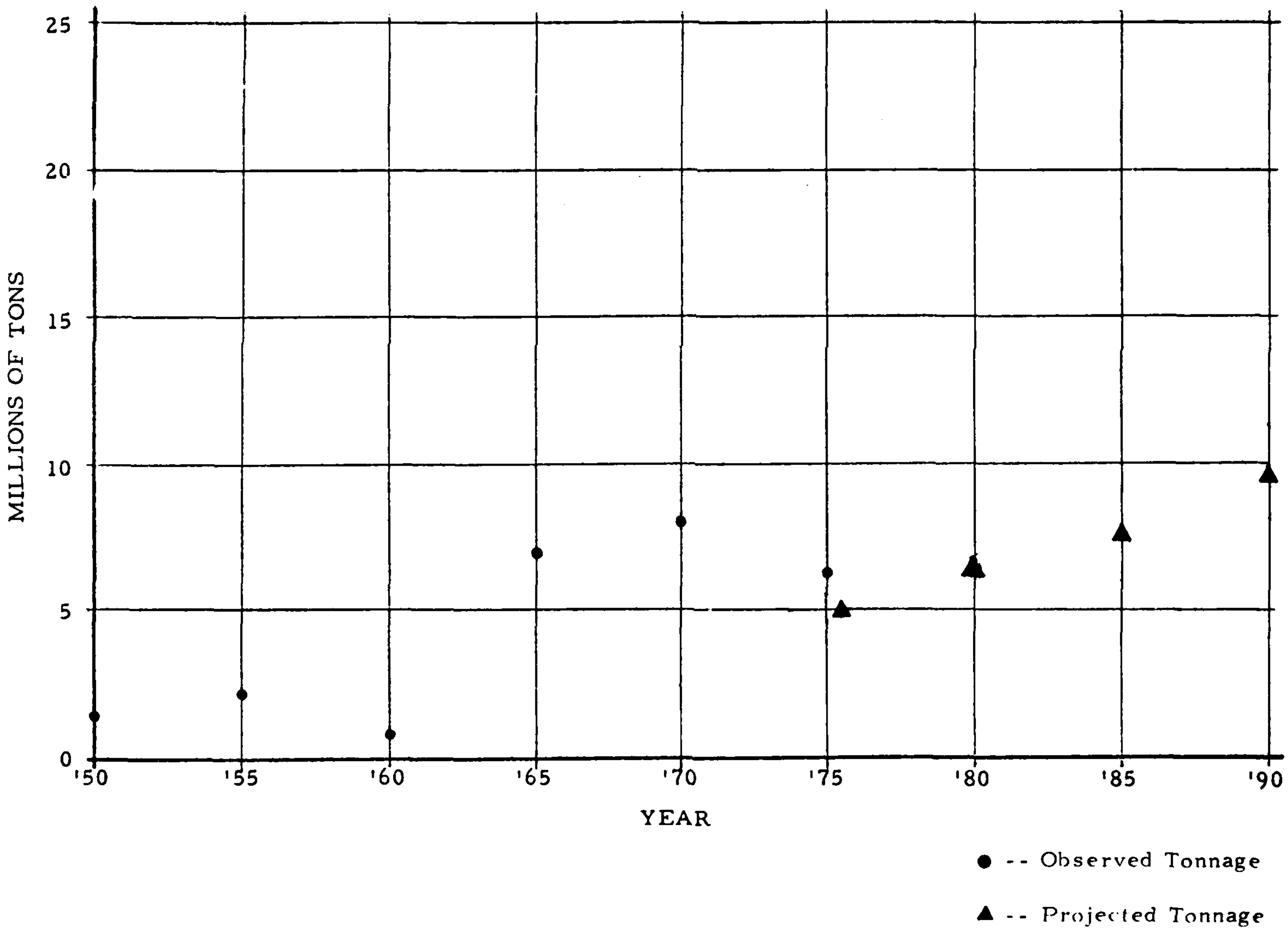
Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	4,692	142	4,550	5,113	146	4,967	6,172	160	6,012	7,400	164	7,236
2	343	343	0	414	414	0	499	499	0	590	590	0
4	590	4	586	781	5	776	899	5	894	1,016	5	1,011
5	0	0	0	0			0			0		
6	0	0	0	0			0			0		
7	44	44	0	115	115	0	216	216	0	393	393	0
8	0	0	0	0			0			0		
9	34	34	0	41	41	0	53	53	0	64	64	0
3	0	0	0	0	0	0	0	0	0	0	0	0
Total	5,703	567	5,136	6,464	721	5,743	7,839	933	6,906	9,463	1,216	8,247

Base Year Assignment** = 5,704

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Monongahela L&D #8 - (mile 90. 8)



...ED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Monongahela Morgantown L&D (mile 102.0)

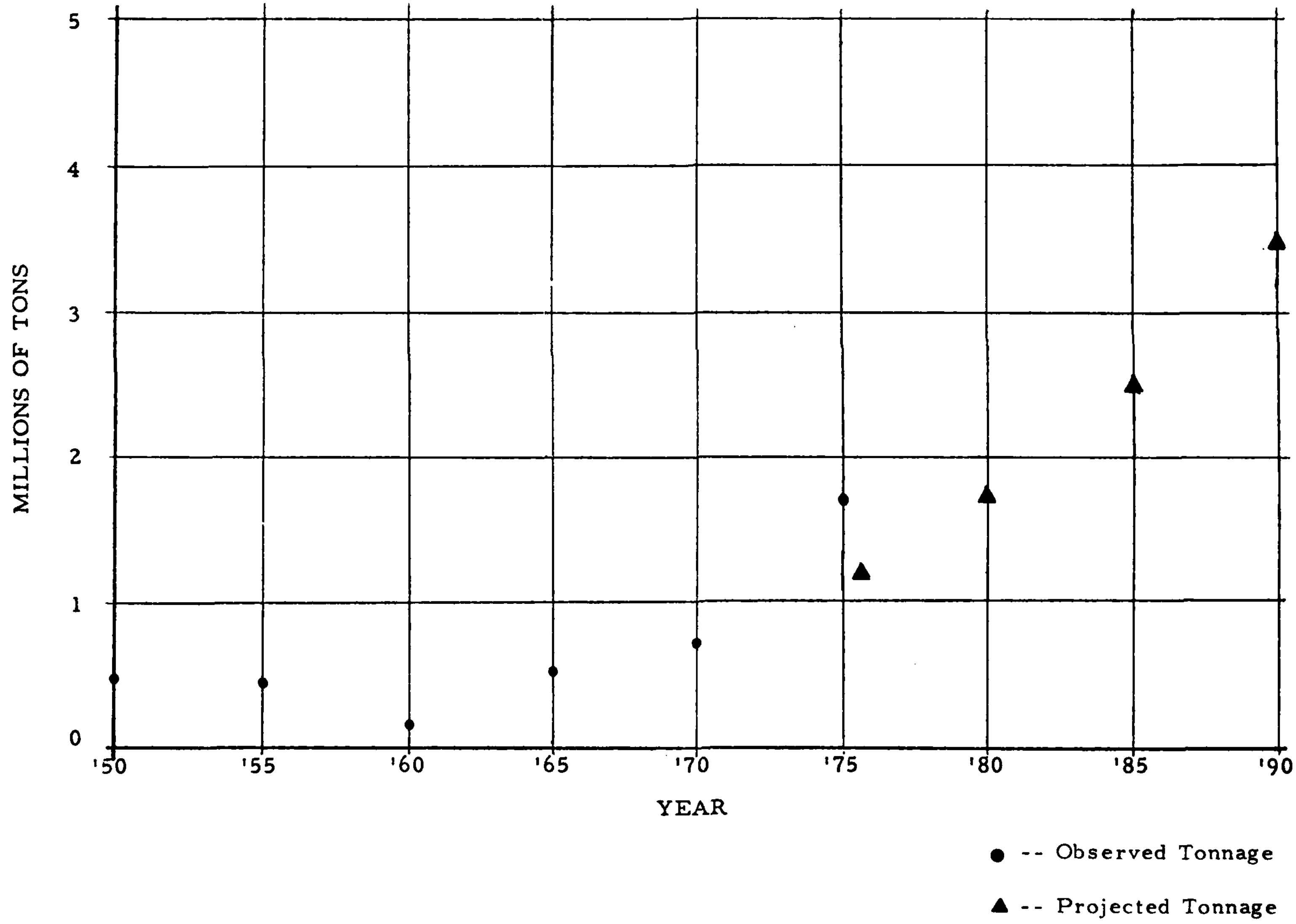
Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	731	7	724	954	6	948	1,387	7	1,380	2,041	6	2,035
2	0	0	0	0			0			0		
4	587	3	584	777	4	773	896	5	891	1,013	5	1,008
5	0	0	0	0			0			0		
6	0	0	0	0			0			0		
7	44	44	0	115	115	0	216	216	0	393	393	0
8	0	0	0	0			0			0		
9	34	34	0	41	41	0	53	53	0	64	64	0
3	0	0	0	0	0	0	0	0	0	0	0	0
Total	1,396	88	1,308	1,887	166	1,721	2,552	281	2,271	3,511	468	3,043

Base Year Assignment** = 1,396

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Morgantown L&D - (mile 102.0)



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Monongahela Hildebrand L&D (mile 108.0)

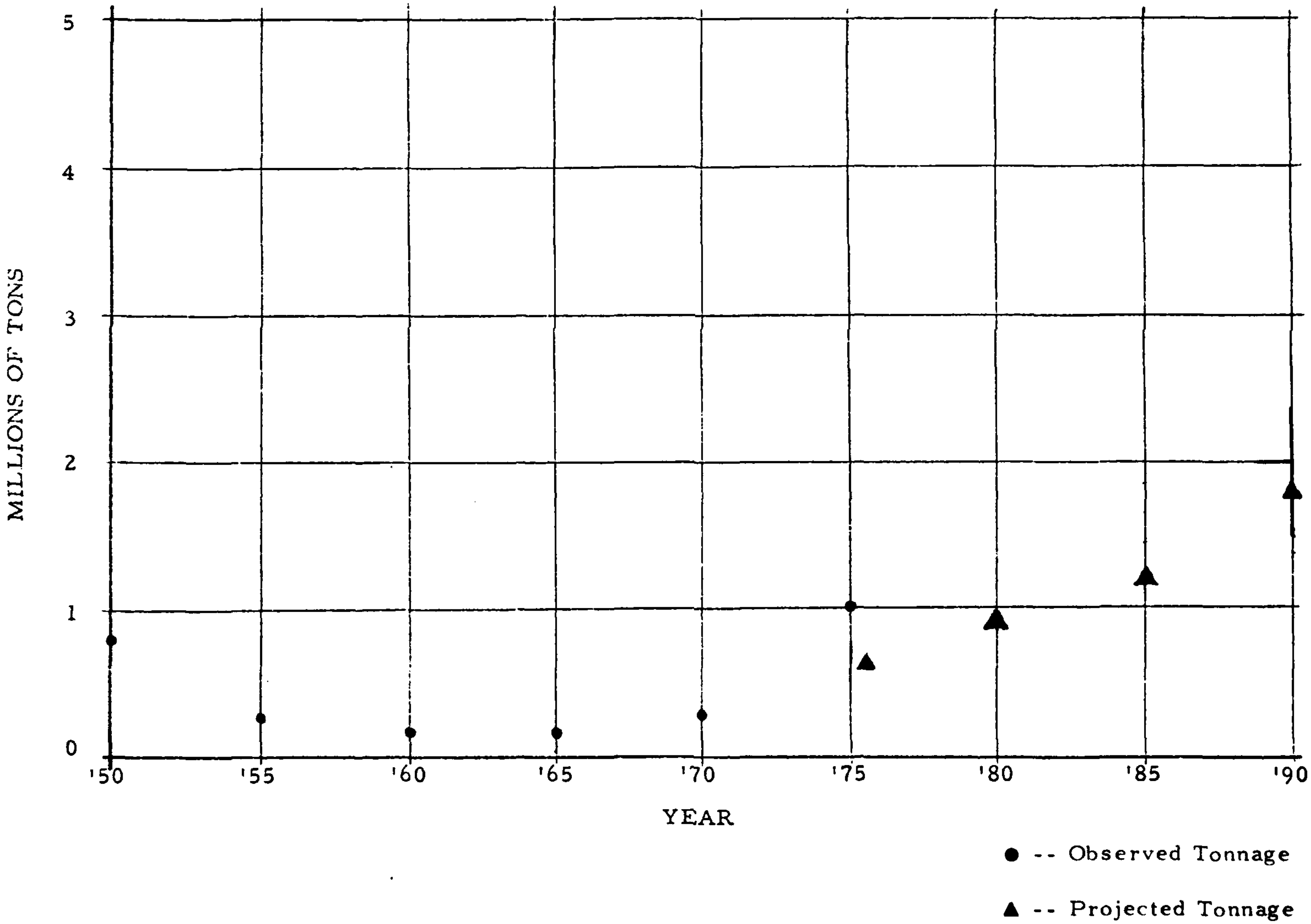
Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	614	7	607	750	6	744	1,012	7	1,005	1,363	6	1,357
2	0	0	0	0			0			0		
4	0	0	0	0			0			0		
5	0	0	0	0			0			0		
6	0	0	0	0			0			0		
7	44	44	0	115	115	0	216	216	0	393	393	0
8	0	0	0	0			0			0		
9	34	34	0	41	41	0	53	53	0	64	64	0
3	0	0	0	0	0	0	0	0	0	0	0	0
Total	692	85	607	906	162	744	1,281	276	1,005	1,820	463	1,357

Base Year Assignment** = 692

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Hildebrand L&D - (mile 108.0)



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Monongahela Cpekista L&D (mile 115.4)

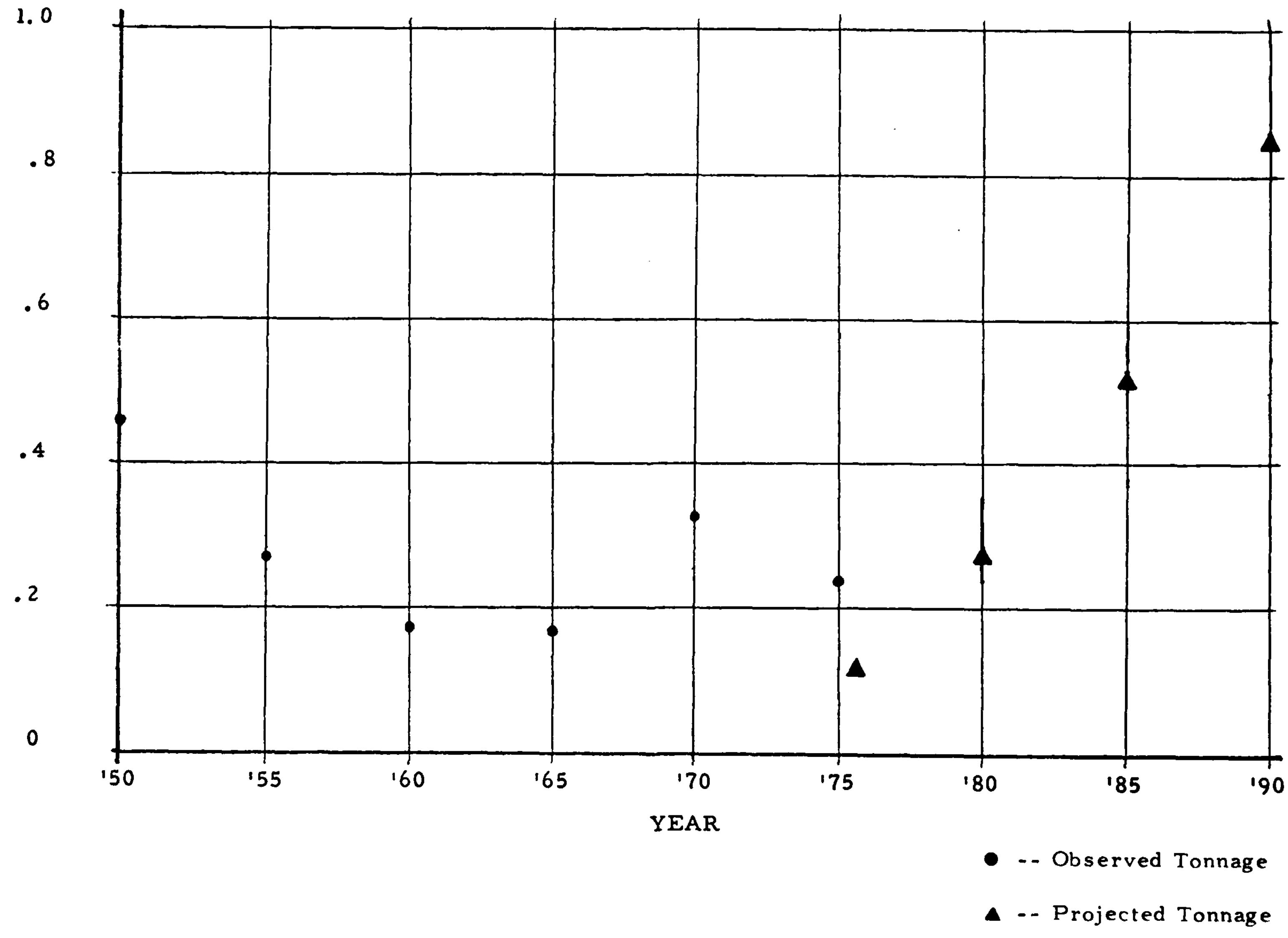
Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	90	7	83	142	6	136	243	7	236	409	6	403
2	0	0	0	0			0			0		
4	0	0	0	0			0			0		
5	0	0	0	0			0			0		
6	0	0	0	0			0			0		
7	44	44	0	115	115	0	216	216	0	393	393	0
8	0	0	0	0			0			0		
9	34	34	0	41	41	0	53	53	0	64	64	0
3	0	0	0	0	0	0	0	0	0	0	0	0
Total	168	85	83	298	162	136	512	276	236	866	463	403

Base Year Assignment** = 168

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Opekista L&D - (mile 115.4)



PROJECTED LOCK AND DAM TRAFFIC

ALLEGHENY RIVER

PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Allegheny L&D #2 (mile 6.7)

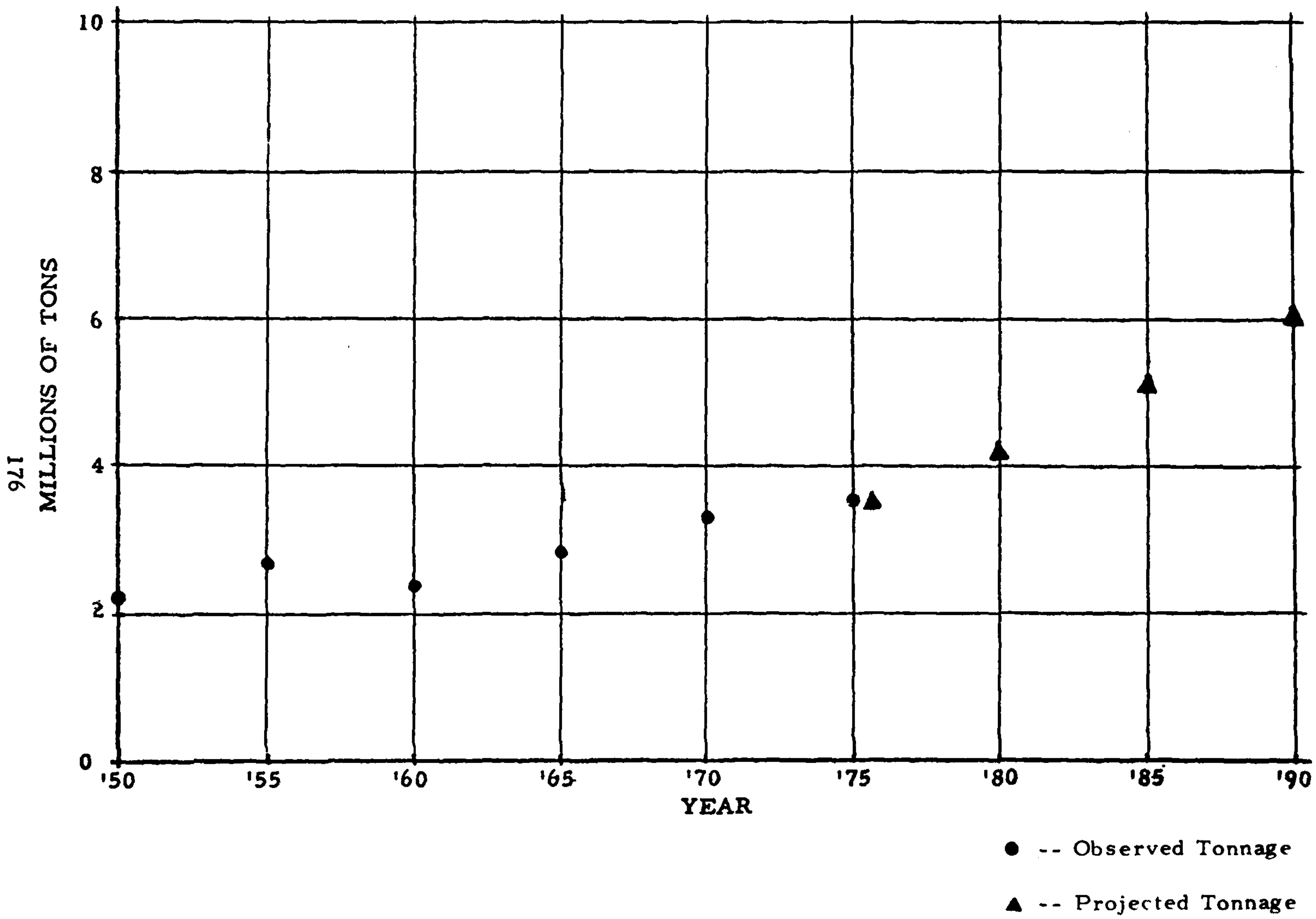
Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	1,860	795	1,065	1,988	830	1,158	2,362	961	1,401	2,767	1,090	1,677
2	55	55	0	278	238	40	351	303	48	433	377	57
4	544	41	503	689	72	617	854	64	790	1,045	58	987
5	0	0	0	0	0	0	0	0	0	0	0	0
6	84	76	8	141	141	0	180	180	0	221	221	0
7	169	164	5	264	262	2	315	311	4	362	355	7
8	173	168	5	238	230	8	261	251	10	286	275	11
9	366	349	17	632	603	29	783	749	34	938	898	39
3	3	3	0	0	0	0	0	0	0	0	0	0
Total	3,254	1,651	1,603	4,230	2,376	1,854	5,106	2,819	2,287	6,052	3,274	2,778

Base Year Assignment** = 3,543

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Allegheny L&D #2



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Allegheny L&D #3 (mile 14.5)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	1,424	789	635	1,534	828	706	1,836	956	880	2,177	1,086	1,091
2	55	55	0	278	238	40	351	303	48	433	377	57
4	544	41	503	689	72	617	854	64	790	1,045	58	987
5	0	0	0	0	0	0	0	0	0	0	0	0
6	84	76	8	141	141	0	180	180	0	221	221	0
7	169	164	5	264	262	2	315	311	4	362	355	7
8	172	167	5	237	230	7	259	251	8	284	275	9
9	366	349	17	632	603	29	783	749	34	938	898	39
3	3	3	0	0	0	0	0	0	0	0	0	0
Total	2,817	1,644	1,173	3,775	2,374	1,401	4,578	2,814	1,764	5,460	3,270	2,190

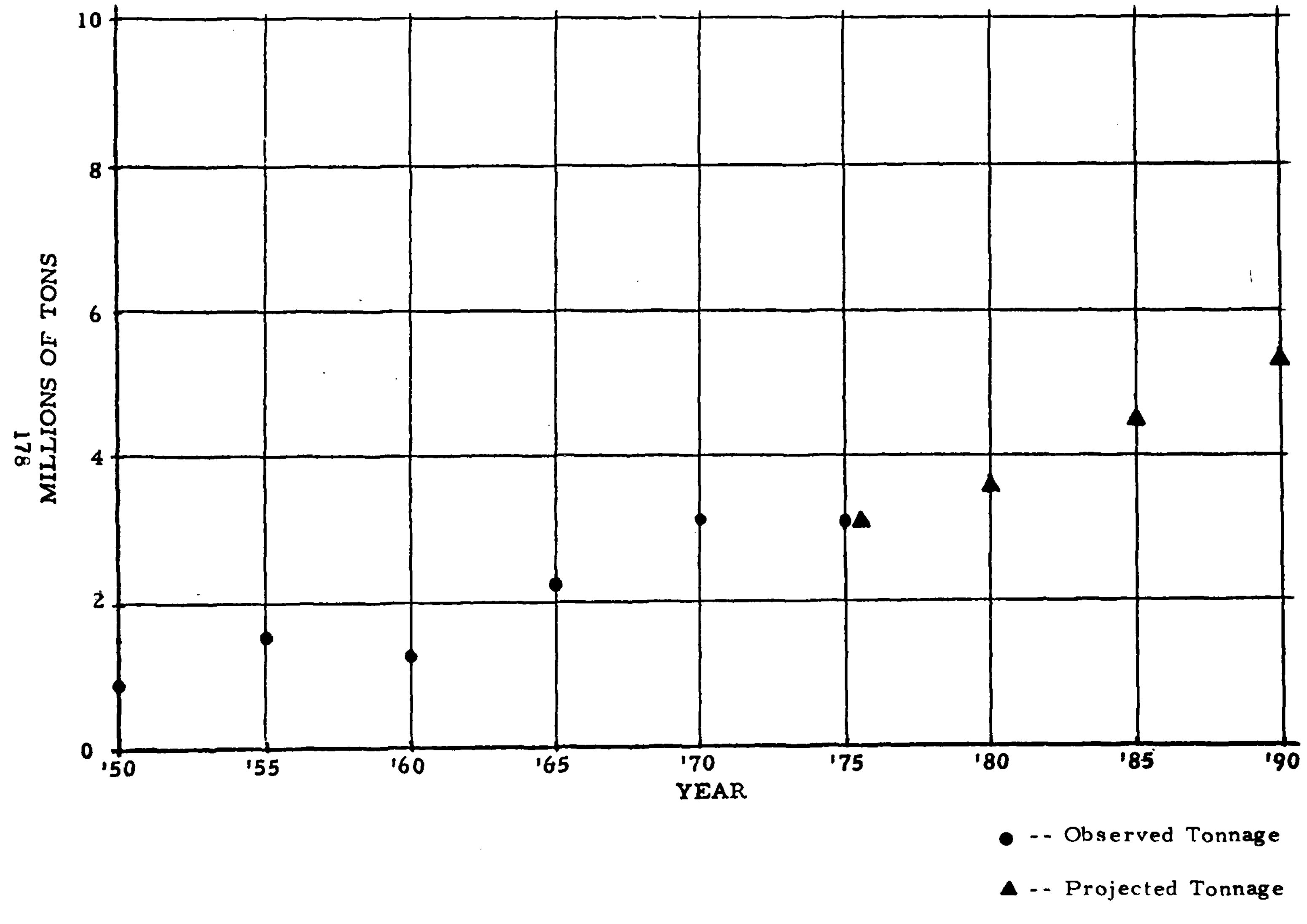
Base Year Assignment** = 3,108

*Thousands of tons.

**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Allegheny L&D #3



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Allegheny L&D #4 (mile 24.2)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	188	0	188	255	0	255	372	0	372	532	0	532
2	27	27	0	32	32	0	41	41	0	50	50	0
4	3	3	0	2,014	0	2,014	2,403	0	2,403	2,811	0	2,811
5	1,477	0	1,477	0	0	0	0	0	0	0	0	0
6	0	0	0	6	6	0	7	7	0	9	9	0
7	4	0	4	0	0	0	0	0	0	0	0	0
8	105	102	3	149	145	4	161	156	5	178	173	5
9	160	148	12	196	178	18	243	222	21	290	266	24
3	0	0	0	0	0	0	0	0	0	0	0	0
Total	1,964	280	1,684	2,652	361	2,291	3,227	426	2,801	3,870	498	3,372

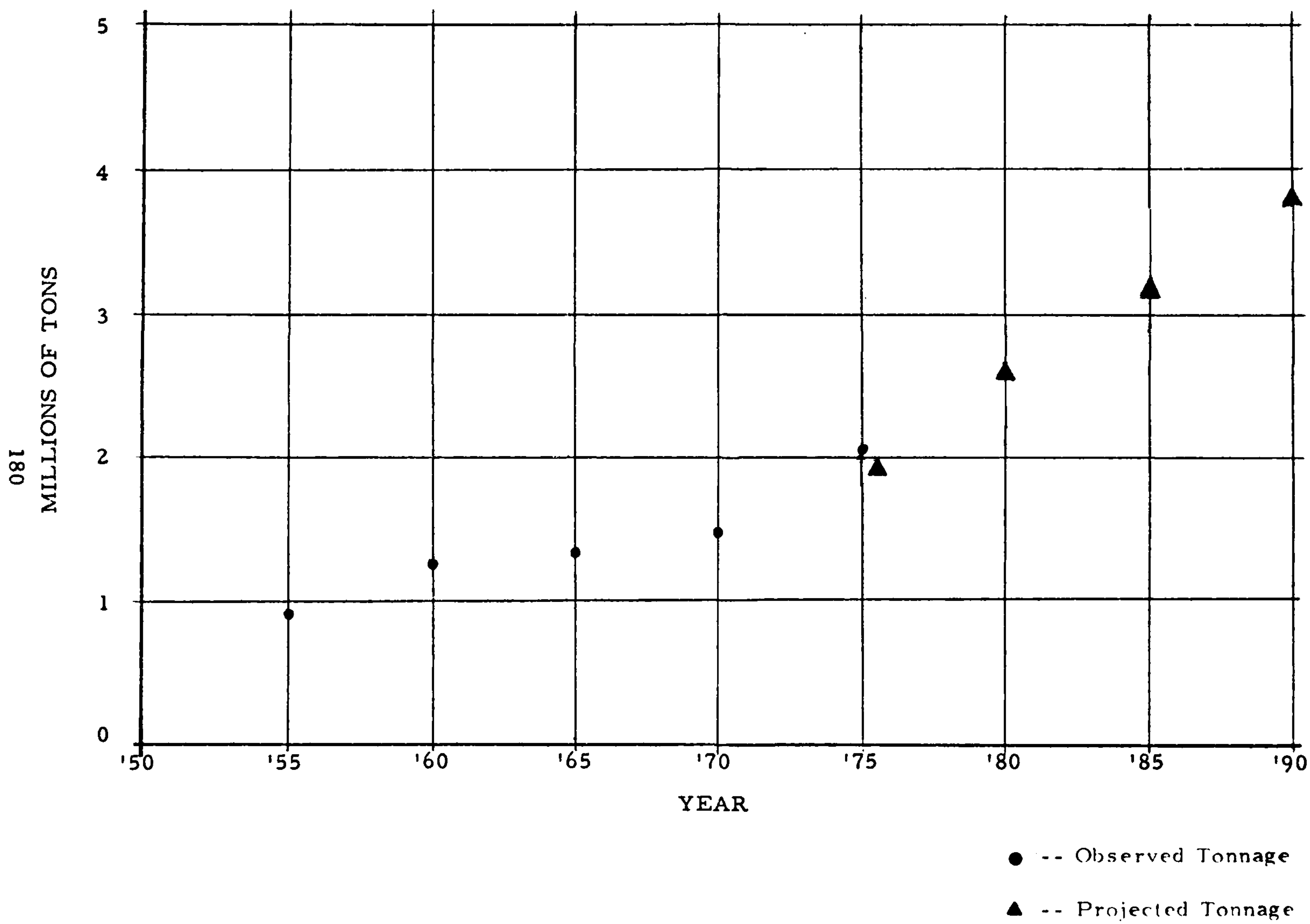
Base Year Assignment** = 1,968

*Thousands of tons.

**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Allegheny L&D #4 - (mile 24.2)



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Allegheny L&D #5 (mile 30.4)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	3	0	3	3	0	3	4	0	4	4	0	4
2	0	0	0	0	0	0	0	0	0	0	0	0
4	1,477	0	1,477	2,014	0	2,014	2,403	0	2,403	2,811	0	2,811
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
Total	1,480	0	1,480	2,017	0	2,017	2,407	0	2,407	2,815	0	2,815

Base Year Assignment** = 1,480

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

AD-A087 194 CONSAD RESEARCH CORP PITTSBURGH PA F/G 5/3

PROJECTING THE DEMAND FOR OHIO RIVER BASIN WATERWAY TRAFFIC USI--ETC(U)

JAN 79 DACW69-78-C-0018

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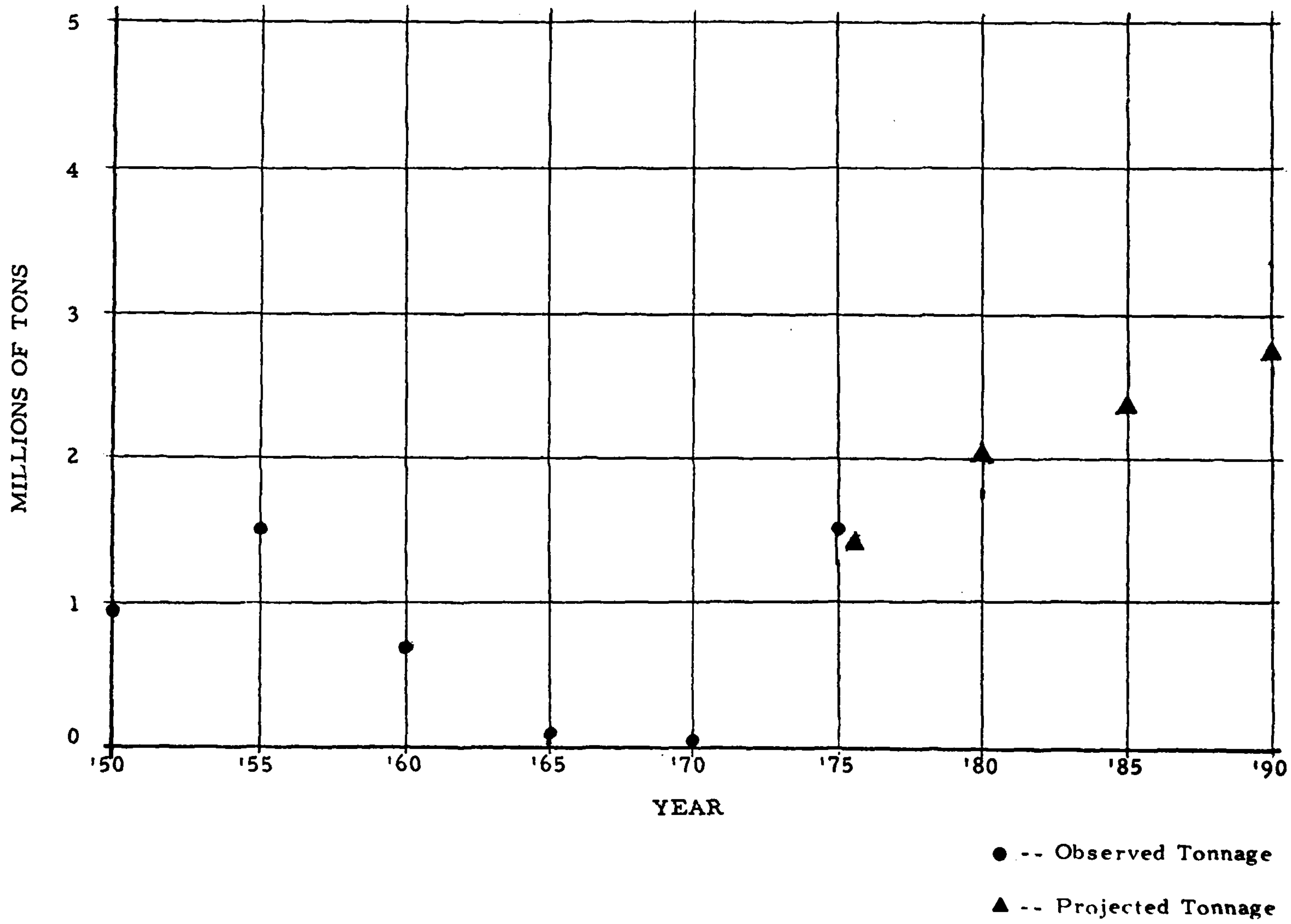
Allegheny L&D #5 - (mile 30.4)



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Allegheny L&D #6 (mile 36.3)

Com-modity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	3	0	3	3	0	3	4	0	4	4	0	4
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
Total	3	0	3	3	0	3	4	0	4	4	0	4

Base Year Assignment** = 3

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

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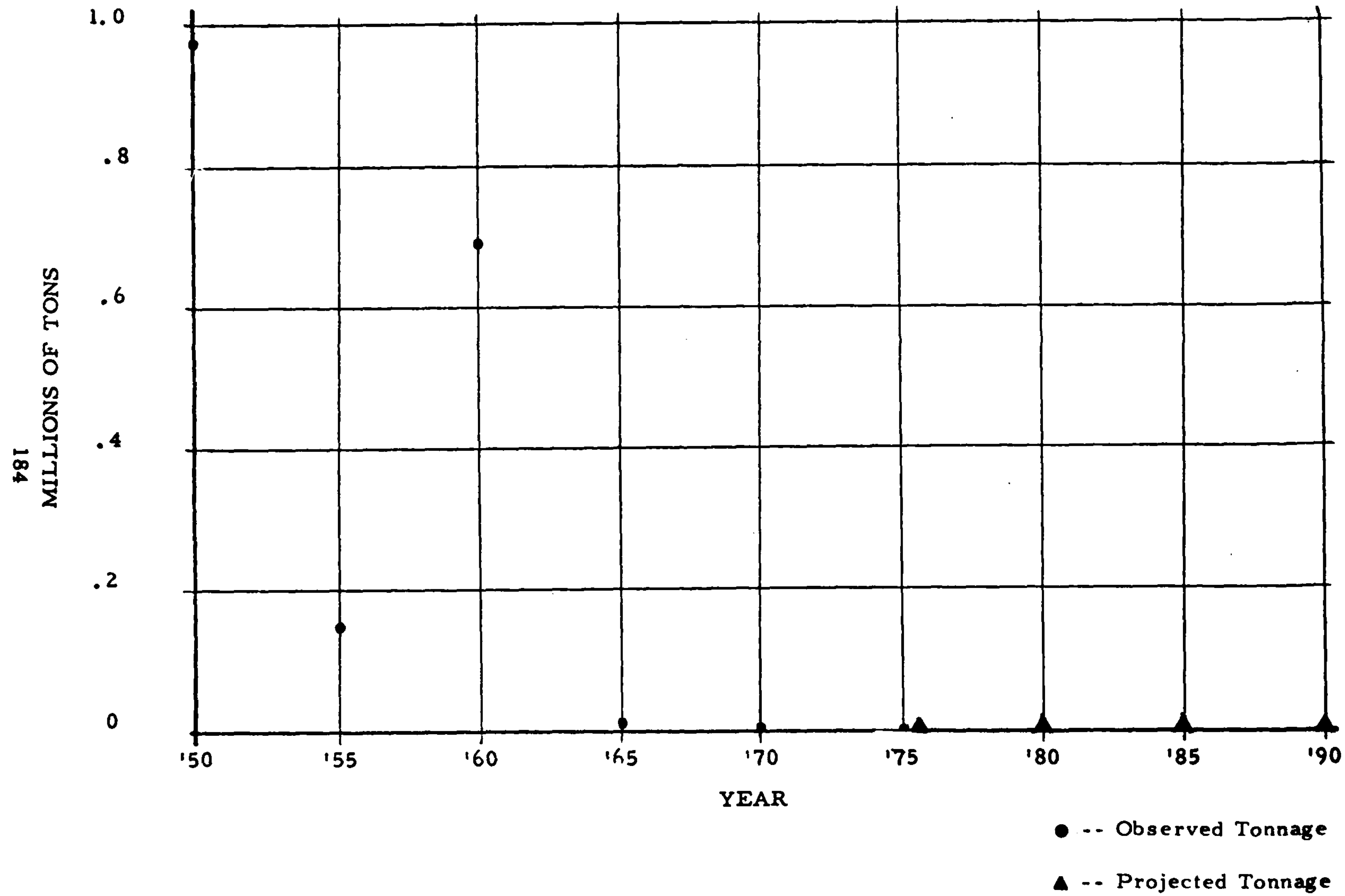
Allegheny L&D #6 - (mile 36.3)



Allegheny L&D #7
8
9

0 Tons, All Commodities, Both Directions

PROJECTED LOCK AND DAM TRAFFIC

KANAWHA RIVER

PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Kanawha R.
Winfield L&D (mile 31.1)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	3,981	503	3,478	3,967	790	3,177	4,478	1,425	3,053	5,423	2,702	2,721
2	1,108	1,066	42	1,484	1,429	55	1,883	1,813	70	2,345	2,257	88
4	2,126	2,124	2	2,952	2,950	2	3,556	3,553	3	4,206	4,203	3
5	0	0	0	0			0			0		
6	1,620	1,306	314	3,548	3,206	342	4,432	3,995	437	5,337	4,803	534
7	155	151	4	292	284	8	356	347	9	430	418	12
8	41	6	35	60	10	50	72	16	56	84	22	62
9	261	235	26	306	280	26	370	339	31	433	397	36
3	0	0	0	0	0	0	0	0	0	0	0	0
Total	9,292	5,391	3,901	12,609	8,949	3,660	15,147	11,488	3,659	18,258	14,802	3,456

Base Year Assignment** = 10,263

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

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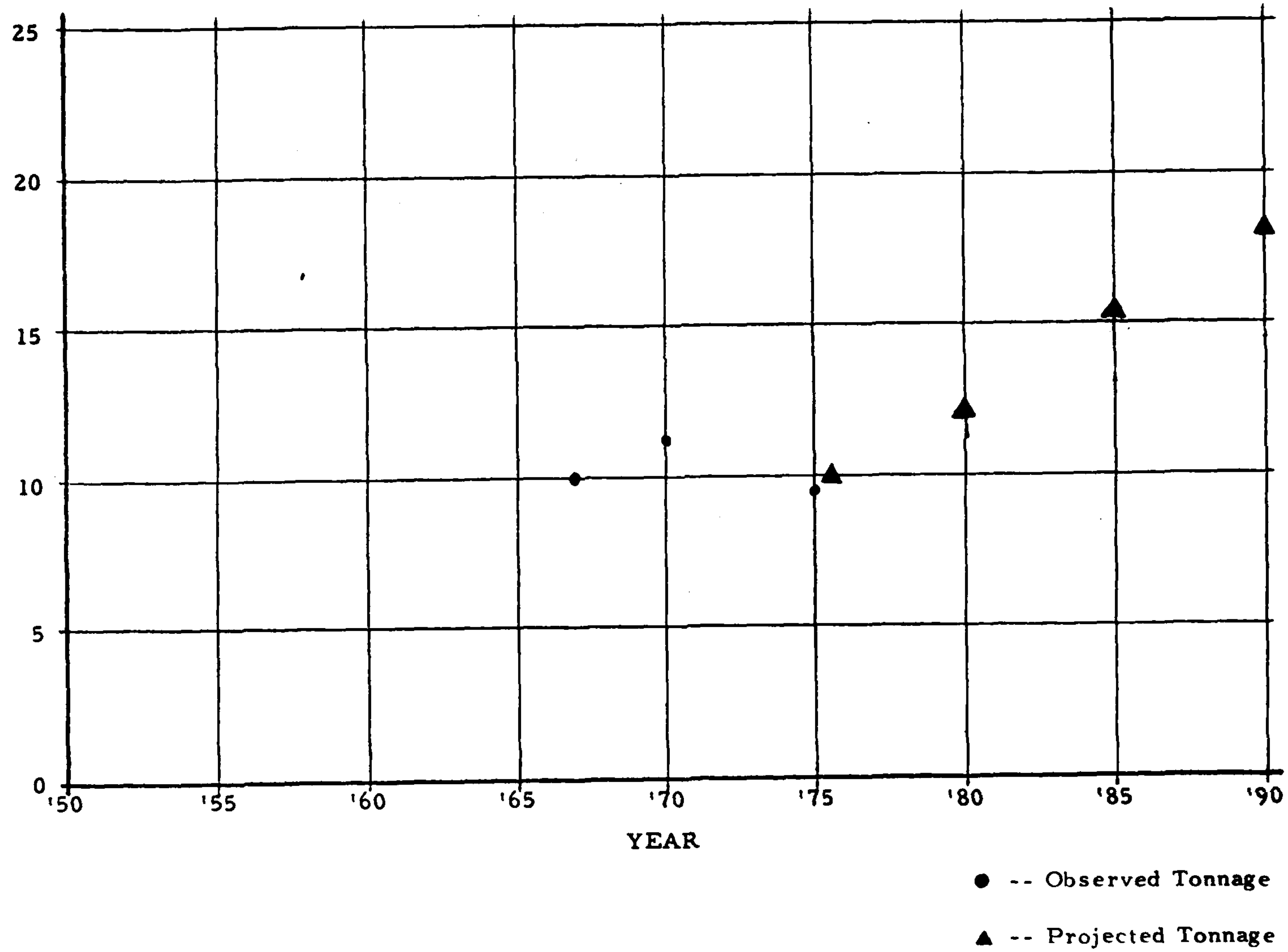
Winfield L&D - (mile 31.1)



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Kanawha River
Marmet L&D (mile 67.8)

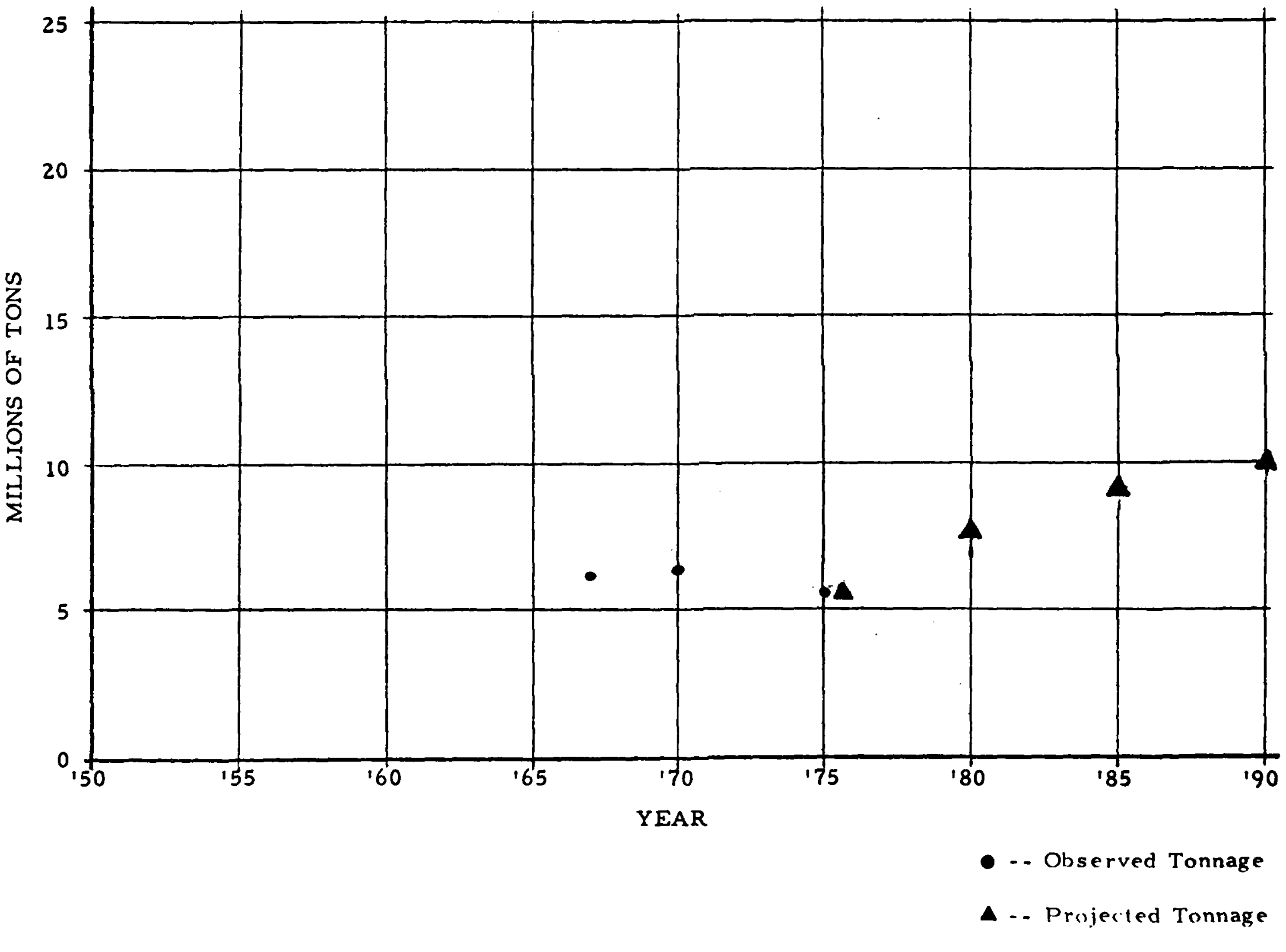
Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	5,115	228	4,887	5,575	276	5,299	6,711	374	6,337	7,953	508	7,445
2	500	492	8	667	657	10	846	833	13	1,054	1,037	17
4	120	120	-	175	175	0	218	218	0	296	296	0
5	0	0	0	0			0			0		
6	443	325	118	391	330	61	490	414	76	588	496	92
7	89	85	4	164	156	8	203	194	9	253	241	12
8	12	4	8	16	5	11	22	9	13	27	13	14
9	77	58	19	92	72	20	112	89	23	132	106	26
3	0	0	0	0	0	0	0	0	0	0	0	0
Total	6,356	1,312	5,044	7,080	1,671	5,409	8,602	2,131	6,471	10,303	2,697	7,606

Base Year Assignment** = 6,195

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Marmet L&D - (mile 67.8)



Revised 1/79

PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Kanawha River
London L&D (mile 82.8)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	**1,214**	**11**	**1,203**	1,218	12	1,206	1,351	13	1,338	1,465	14	1,451
2	**169**	**169**	**0**	206	206	0	261	261	0	326	326	0
4	**99**	**99**	**0**	56	56	0	64	64	0	72	72	0
5	**0**	**0**	**0**	0			0			0		
6	**1**	**1**	**0**	0			0			0		
7	**60**	**56**	**4**	90	82	8	116	107	9	155	143	12
8	**12**	**4**	**8**	16	5	11	22	9	13	27	13	14
9	**47**	**44**	**3**	59	56	3	74	70	4	88	84	4
3	0	0	0	0	0	0	0	0	0	0	0	0
Total	**1,602**	**384**	**1,218**	1,645	417	1,228	1,888	524	1,364	2,133	652	1,481

Base Year Assignment** = 1,516

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

PROJECTED LOCK AND DAM TRAFFIC

KENTUCKY RIVER

PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Kentucky R. L&D #1 - #4

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	0			0			0			0		
2	0			0			0			0		
4	539	539		684	684	0	732	732	0	734	734	0
5	0			0			0			0		
6	0			0			0			0		
7	0			0			0			0		
8	0			0			0			0		
9	0			0			0			0		
3	0			0			0			0		
Total	539	539	0	684	684	0	732	732	0	734	734	0

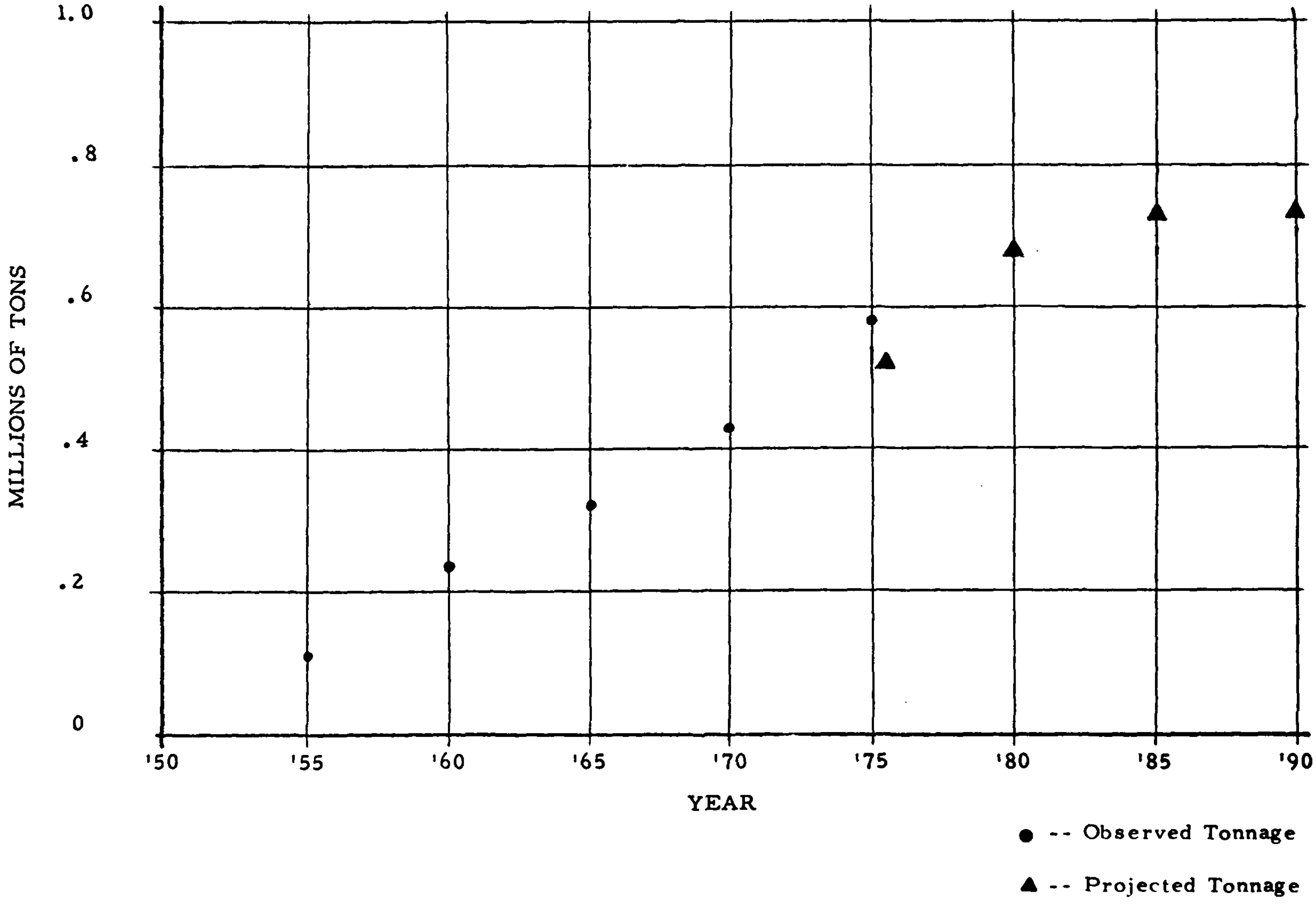
Base Year Assignment** = 539

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Kentucky R. L&D's #5-#14: 0 Tons, All Commodities, Both Directions.

Revised 1/79

Kentucky L&D's #1 - #4



Kentucky L&D's #5-#14

0 Tons, All Commodities, Both Directions

PROJECTED LOCK AND DAM TRAFFIC

GREEN RIVER

PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Green R. L&D #1 (mile 9.1)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	13,296	1	13,295	14,011	2	14,009	16,284	2	16,282	18,515	2	18,513
2	0			0			0			0		
4	0			0			0			0		
5	175	0	175	101	0	101	130	0	130	163	0	163
6	3	3	0	0			0			0		
7	1	1	0	2	2	0	2	2	0	3	3	0
8	0			0			0			0		
9	0			2	2	0	2	2	0	2	2	0
3	0			0			0			0		
Total	13,475	5	13,470	14,116	6	14,110	16,418	6	16,412	18,683	7	18,676

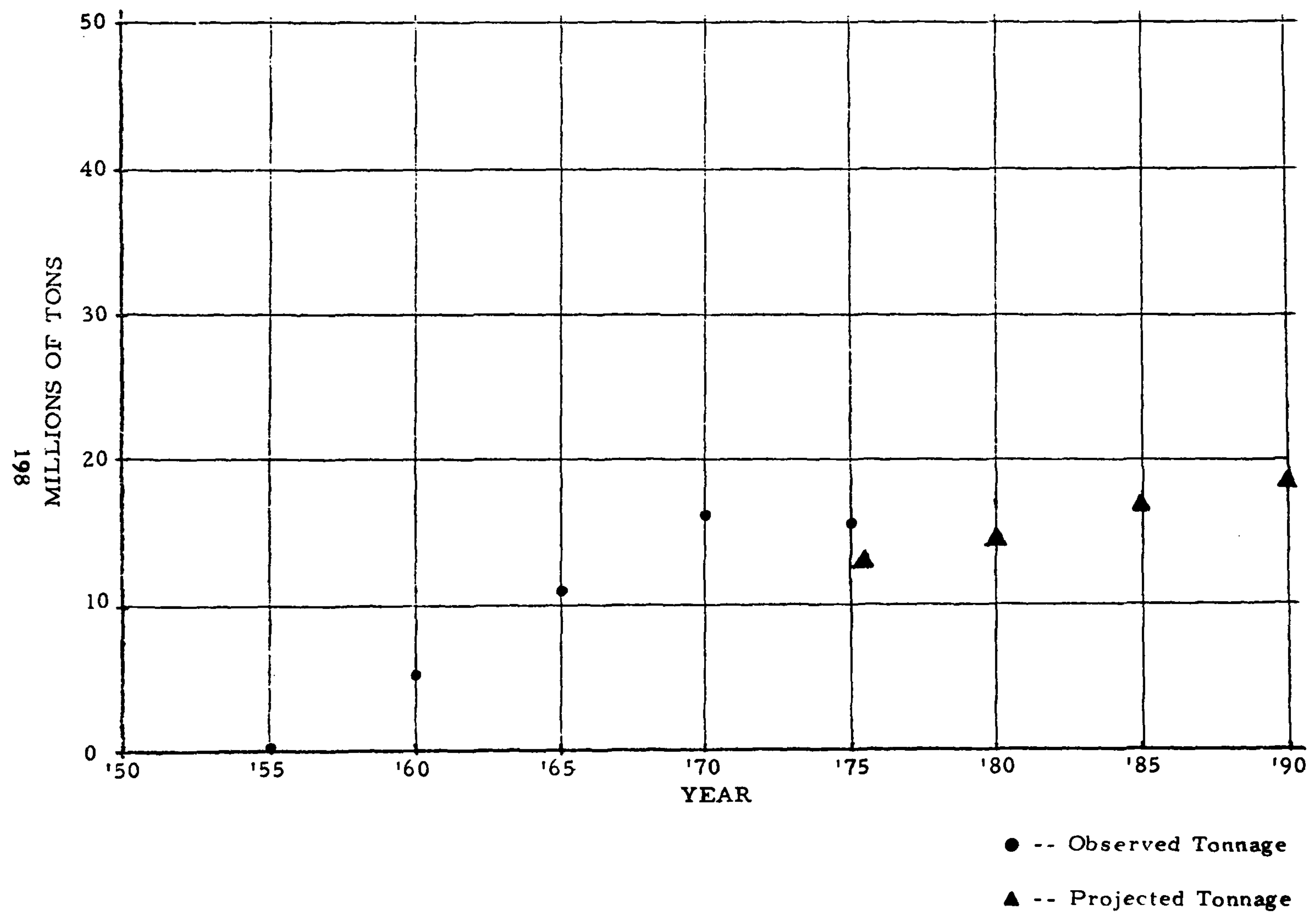
Base Year Assignment** = 13,391

*Thousands of tons.

**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Green #1

Revised 1/79



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Green R. L&D #2 (mile 63.1)

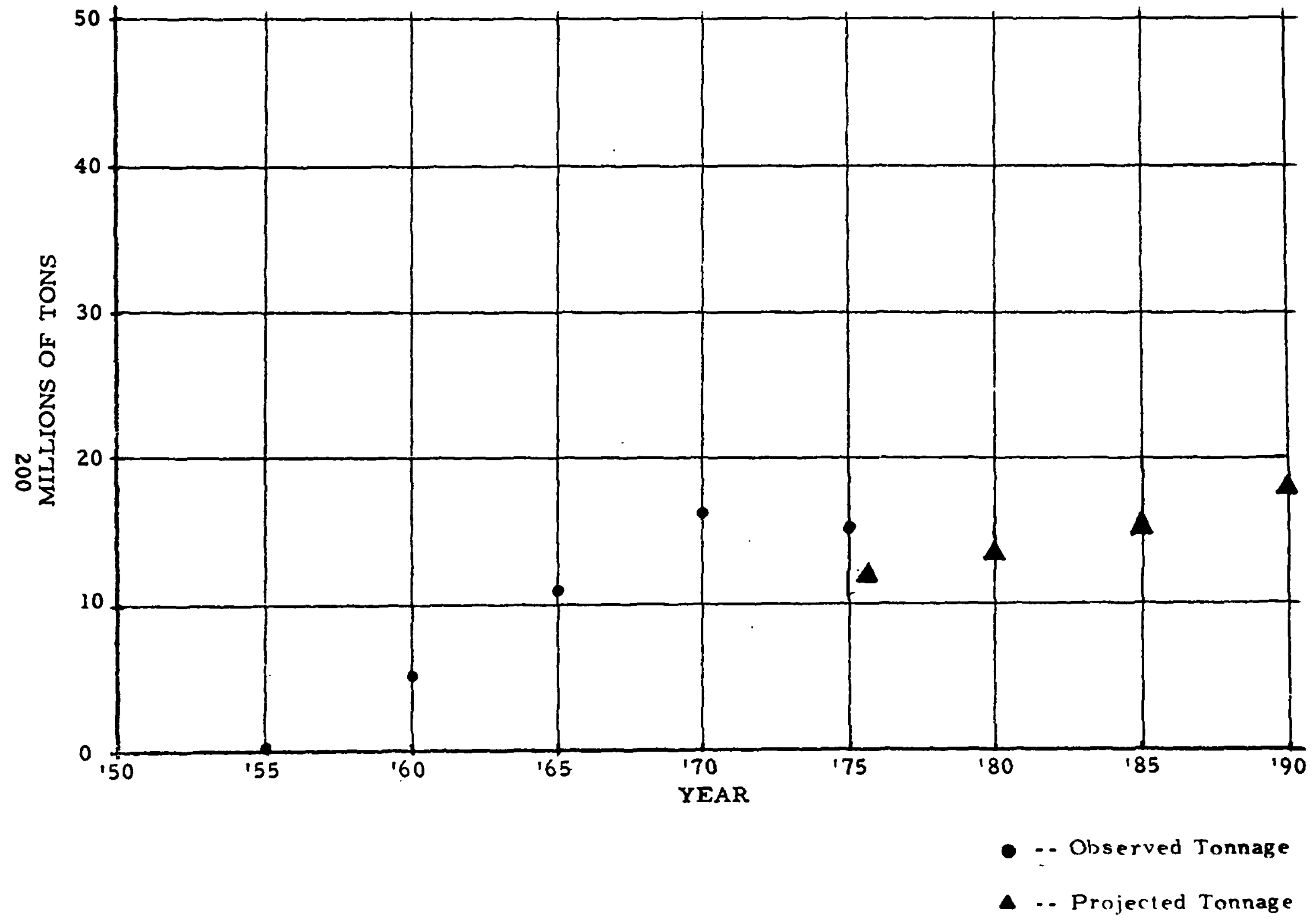
Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	12,589	0	12,589	13,409	0	13,409	15,710	0	15,710	17,987	0	17,987
2	0			0			0			0		
4	0			0			0			0		
5	174		174	101	0	101	130	0	130	163	0	163
6	0			0			0			0		
7	0			0			0			0		
8	0			0			0			0		
9	0			0			0			0		
3	0			0			0			0		
Total	12,763	0	12,763	13,510		13,510	15,840		15,840	18,150		18,150

Base Year Assignment** = 12,680

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Green #2



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Green R. L&D #3 (mile 108.5)

Com- modity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	342	0	342	64	0	64	76	0	76	90	0	90
2	0			0			0			0		
4	0			0			0			0		
5	0			0			0			0		
6	0			0			0			0		
7	0			0			0			0		
8	0			0			0			0		
9	0			0			0			0		
3	0			0			0			0		
Total	342	0	342	64	0	64	76	0	76	90	0	90

Base Year Assignment** = 58

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

PROJECTED LOCK AND DAM TRAFFIC

CUMBERLAND RIVER

PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Cumberland R. Barkley L&D (mile 30.6)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	4,569	4,569	0	8,890	8,873	17	11,392	11,366	26	14,469	14,426	43
2	163	163	0	453	390	63	651	510	141	957	661	296
4	71	71	0	136	136	0	314	314	0	698	698	0
5	0	0	0	55	55	0	87	87	0	148	148	0
6	10	10	0	220	101	119	304	145	159	429	212	217
7	4	4	0	143	137	6	250	240	10	411	391	20
8	0	0	0	282	208	74	388	281	107	541	377	164
9	8	8	0	320	297	23	444	412	32	613	568	45
3	0	0	0	0	0	0	0	0	0	0	0	0
Total	4,825	4,825	0	10,499	10,197	302	13,830	13,355	475	18,266	17,481	785

Base Year Assignment** = 8,769

*Thousands of tons.

**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

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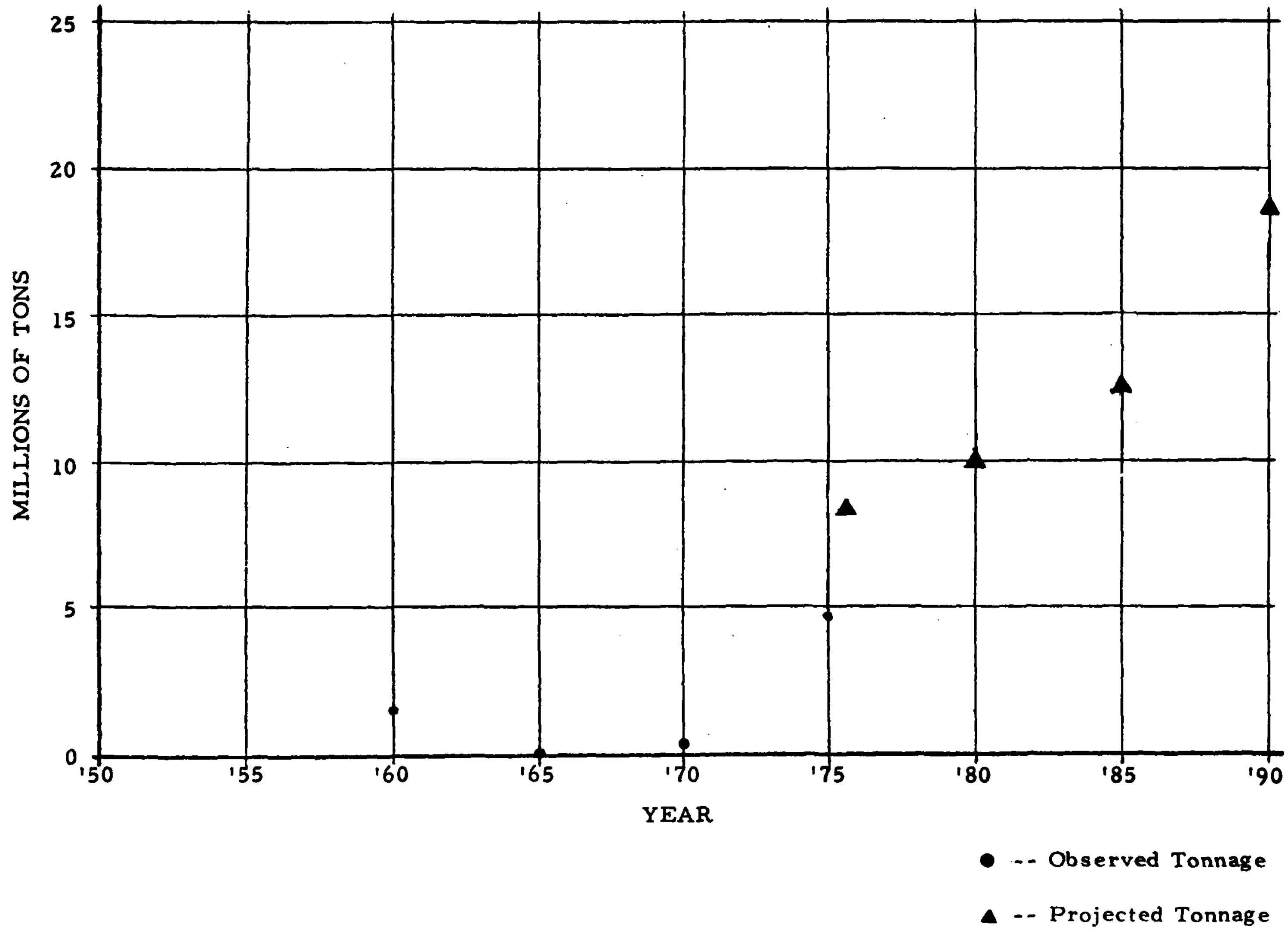
Barkley L&D



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Cumberland R.
Cheatham L&D (mile 148.7)

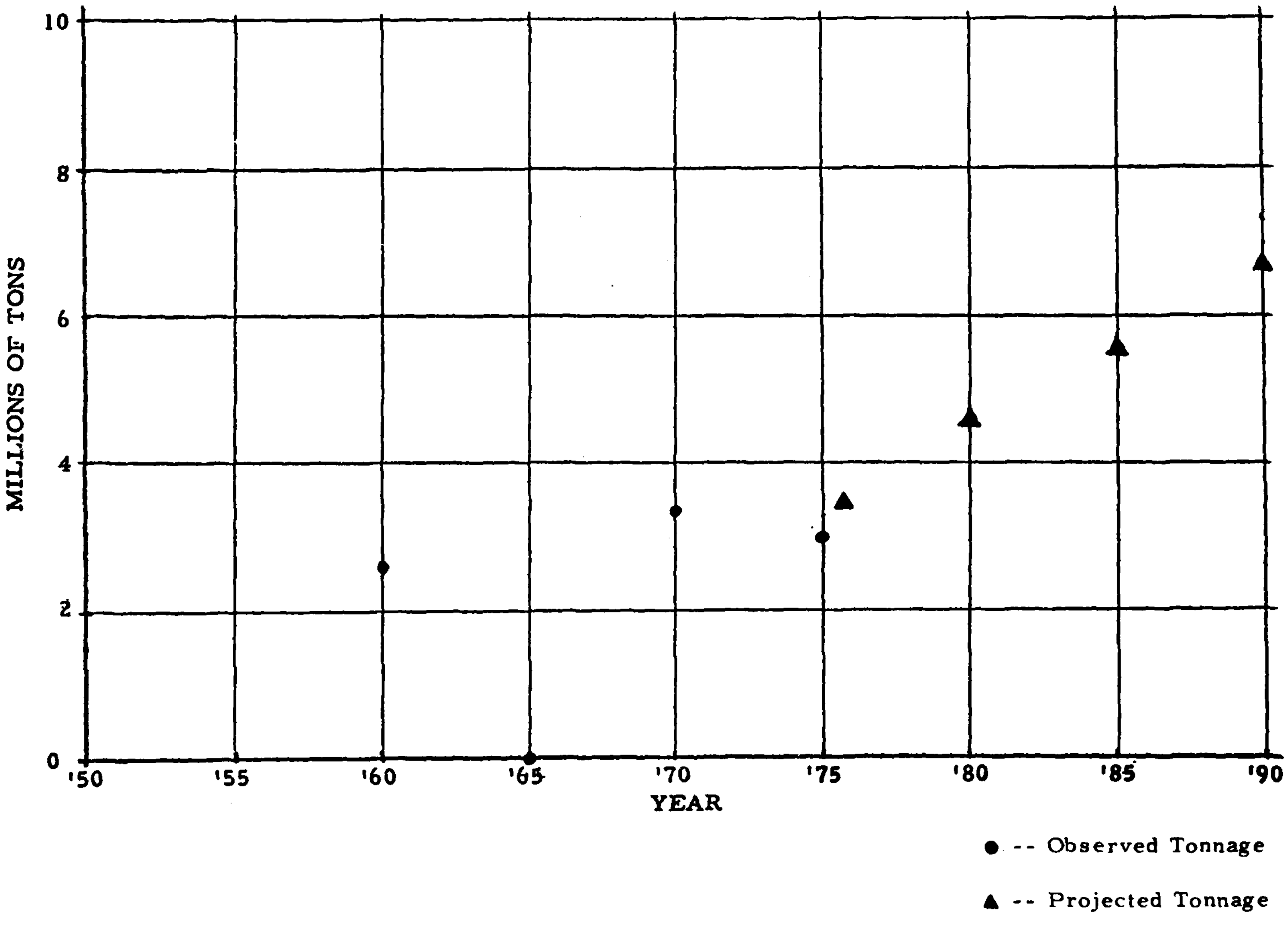
Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	0	0	0	0			0			0		
2	1,253	1,253	0	1,618	1,618	0	2,017	2,017	0	2,448	2,448	0
4	1,241	1,241	0	1,563	1,563	0	1,794	1,794	0	2,137	2,137	0
5	0	0	0	0			0			0		
6	195	171	24	207	175	32	272	231	41	346	295	51
7	23	23	0	48	48	0	66	66	0	91	91	0
8	273	235	38	442	380	62	582	498	84	755	643	112
9	571	462	109	627	618	9	821	811	10	1,050	1,037	13
3	0	0	0	0	0	0	0	0	0	0	0	0
Total	3,556	3,385	171	4,505	4,402	103	5,552	5,417	135	6,827	6,651	176

Base Year Assignment** = 3,505

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Cheatham



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Cumberland R. Old Hickory L&D (mile 216.2)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	0	0	0	0			0			0		
2	94	94	0	121	121	0	154	154	0	186	186	0
4	0	0	0	0			0			0		
5	0	0	0	0			0			0		
6	148	124	24	143	111	32	191	150	41	245	194	51
7	0	0	0	0			0			0		
8	0	0	0	0			0			0		
9	6	6	0	11	11	0	13	13	0	17	17	0
3	0	0	0	0			0			0		
Total	248	224	24	275	243	32	358	317	41	448	397	51

Base Year Assignment** = 199

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

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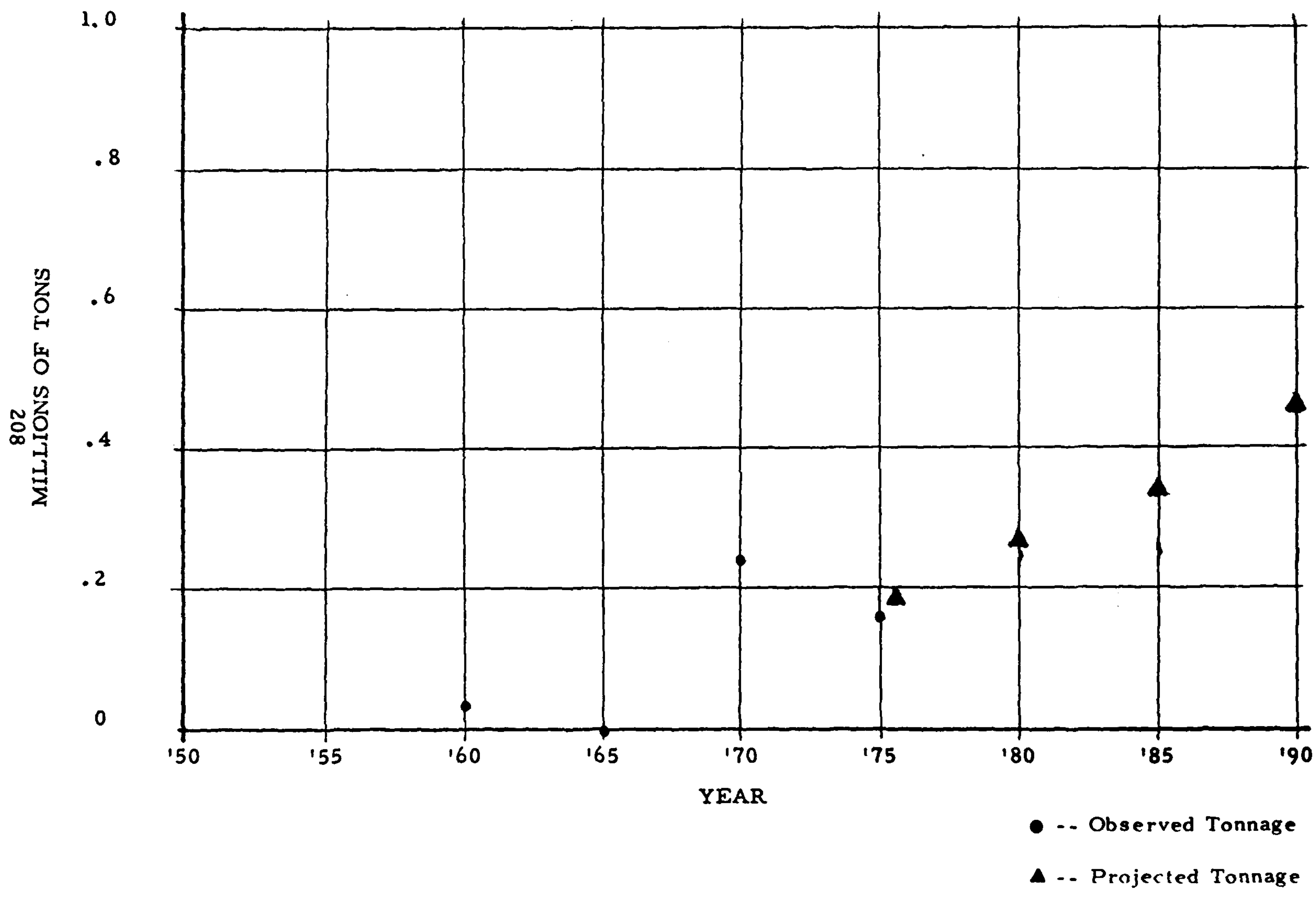
Old Hickory



Cordell Hull L&D

0 Tons, All Commodities, Both Directions

PROJECTED LOCK AND DAM TRAFFIC

TENNESSEE RIVER

PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Kentucky L&D (Tenn. R.) (mile 22.4)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	**6,057**	**3,597**	**2,460**	3,198	528	2,670	3,957	693	3,264	4,874	904	3,970
2	**2,345**	**2,278**	**67**	2,925	2,862	63	3,740	3,650	90	4,667	4,548	119
4	**1,475**	**1,309**	**166**	2,022	1,832	190	2,326	2,138	188	2,621	2,437	184
5	**1,348**	**1,277**	**71**	845	814	31	936	901	35	998	962	36
6	**1,958**	**1,718**	**240**	2,245	2,051	194	3,143	2,894	249	4,264	3,960	304
7	**493**	**447**	**46**	819	720	99	1,053	858	195	1,384	1,012	372
8	**670**	**549**	**121**	790	667	123	998	838	160	1,249	1,040	209
9	**3,952**	**1,429**	**2,523**	2,500	1,580	920	3,273	2,020	1,253	4,146	2,484	1,662
3	**3**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total	**18,301**	**12,604**	**5,697**	15,344	11,054	4,290	19,426	13,992	5,434	24,203	17,347	6,856

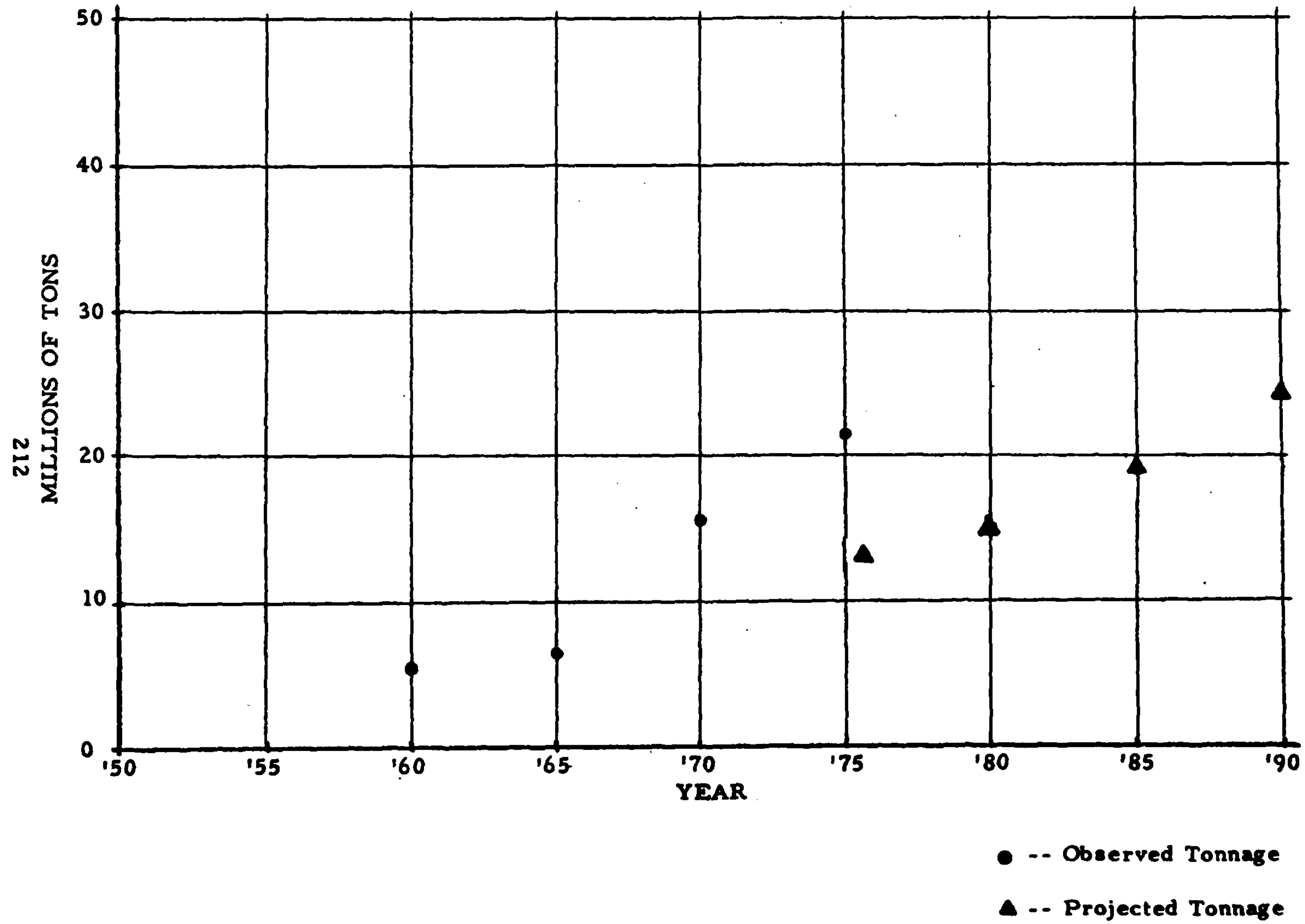
Base Year Assignment** = 13,924

*Thousands of tons.

**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Kentucky L&D (mile 22.4)



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Pickwick L&D (Tenn. R.) (mile 206.7)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	**2,140**	**1,141**	**999**	2,429	1,123	1,306	3,220	1,381	1,839	4,314	1,789	2,525
2	**1,000**	**933**	**67**	1,430	1,304	126	1,963	1,733	230	2,674	2,258	416
4	**78**	**78**	**0**	87	87	0	89	89	0	89	89	0
5	**1,335**	**1,277**	**58**	897	869	28	1,018	988	30	1,140	1,111	29
6	**1,501**	**1,271**	**230**	1,883	1,592	291	2,687	2,299	388	3,708	3,213	495
7	**374**	**335**	**39**	733	630	103	991	788	203	1,369	979	390
8	**327**	**244**	**83**	516	381	135	656	473	183	843	594	259
9	**1,338**	**840**	**498**	1,923	1,133	790	2,543	1,453	1,090	3,270	1,802	1,468
3	3	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total	**8,096**	**6,119**	**1,977**	9,898	7,119	2,779	13,167	9,204	3,963	17,407	11,825	5,582

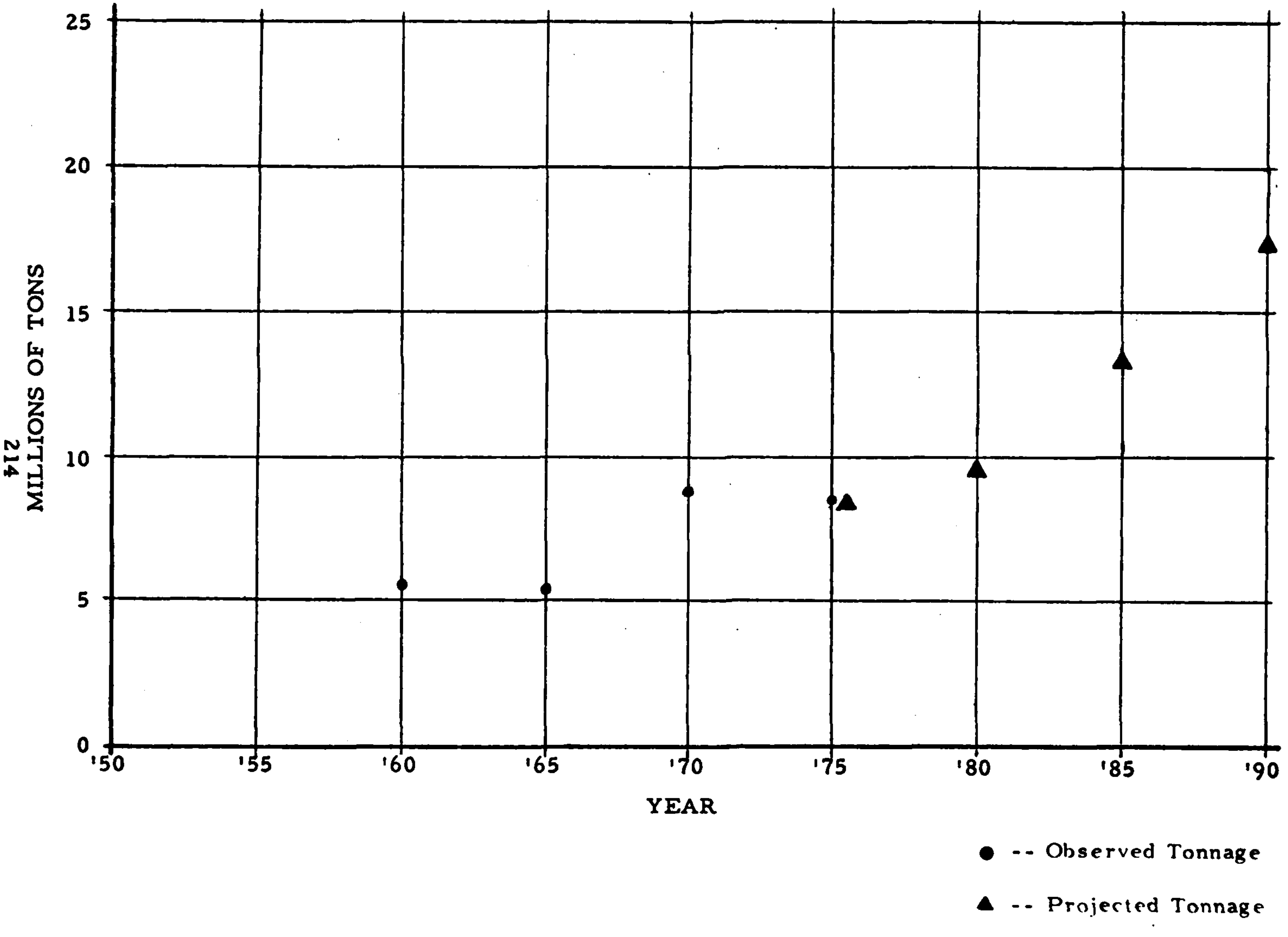
Base Year Assignment** = 7,784

*Thousands of tons.

**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Pickwick L&D (mile 206.7)



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Wilson L&D (Tenn. R.) (mile 259.4)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	**1,759**	**764**	**995**	2,230	938	1,292	3,081	1,282	1,799	4,165	1,741	2,424
2	**758**	**691**	**67**	1,108	983	125	1,552	1,322	230	2,164	1,748	416
4	**11**	**0**	**11**	15	0	15	17	0	17	21	0	21
5	**1,327**	**1,280**	**47**	895	869	26	1,017	988	29	1,140	1,111	29
6	**1,411**	**1,261**	**150**	1,781	1,573	208	2,553	2,273	280	3,538	3,179	359
7	**358**	**329**	**29**	695	619	76	927	776	151	1,256	967	289
8	**278**	**211**	**67**	443	332	111	567	411	156	739	510	229
9	**1,277**	**780**	**497**	1,842	1,055	787	2,434	1,347	1,087	3,126	1,664	1,462
3	**3**	**0**	**3**	0	0	0	0	0	0	0	0	0
Total	**7,182**	**5,316**	**1,866**	9,009	6,369	2,640	12,148	8,399	3,749	16,149	10,920	5,229

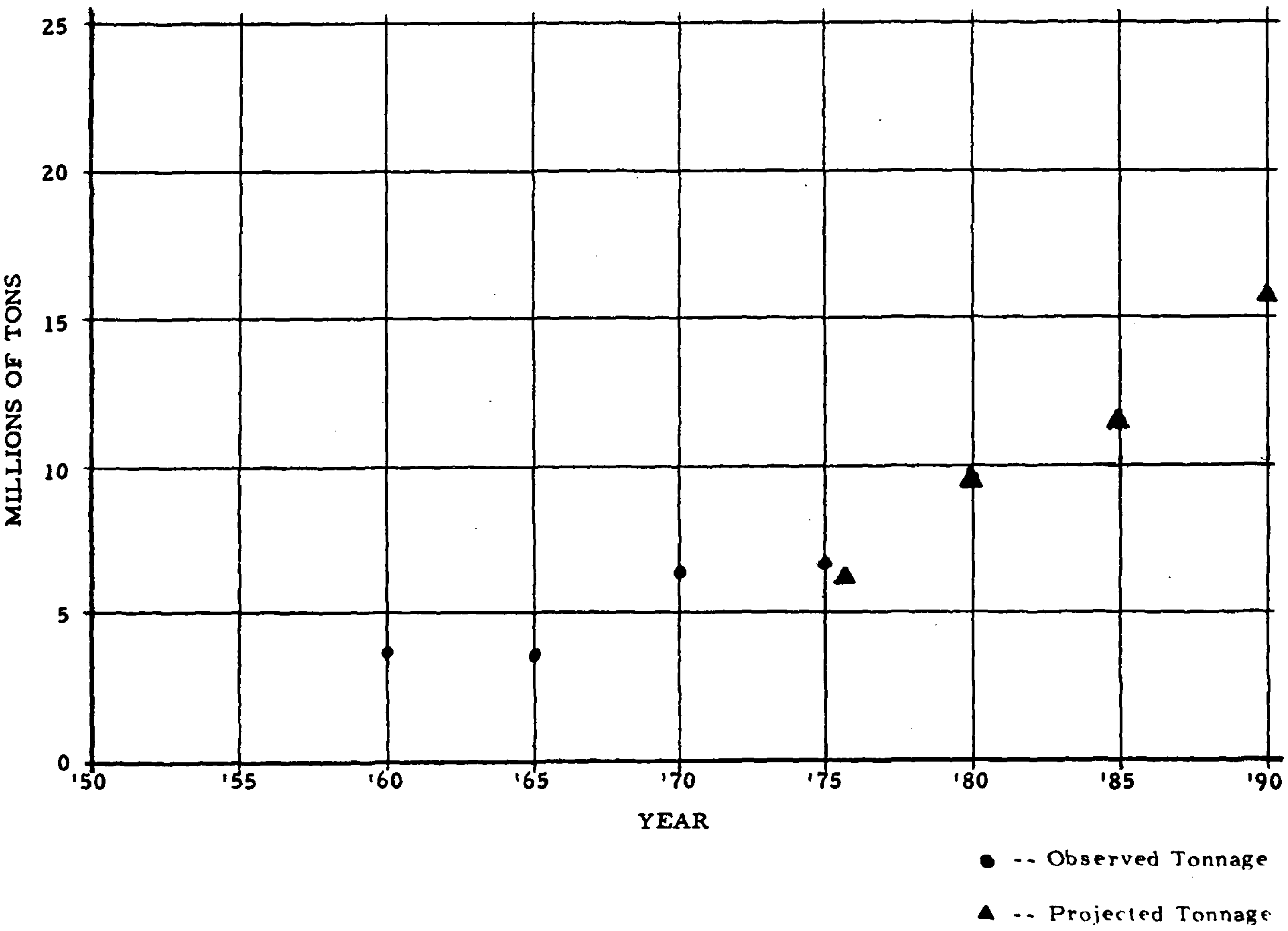
Base Year Assignment** = 6,899

*Thousands of tons.

**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Wilson L&D (mile 259.4)



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Wheeler L&D (Tenn. R.) (mile 274.9)

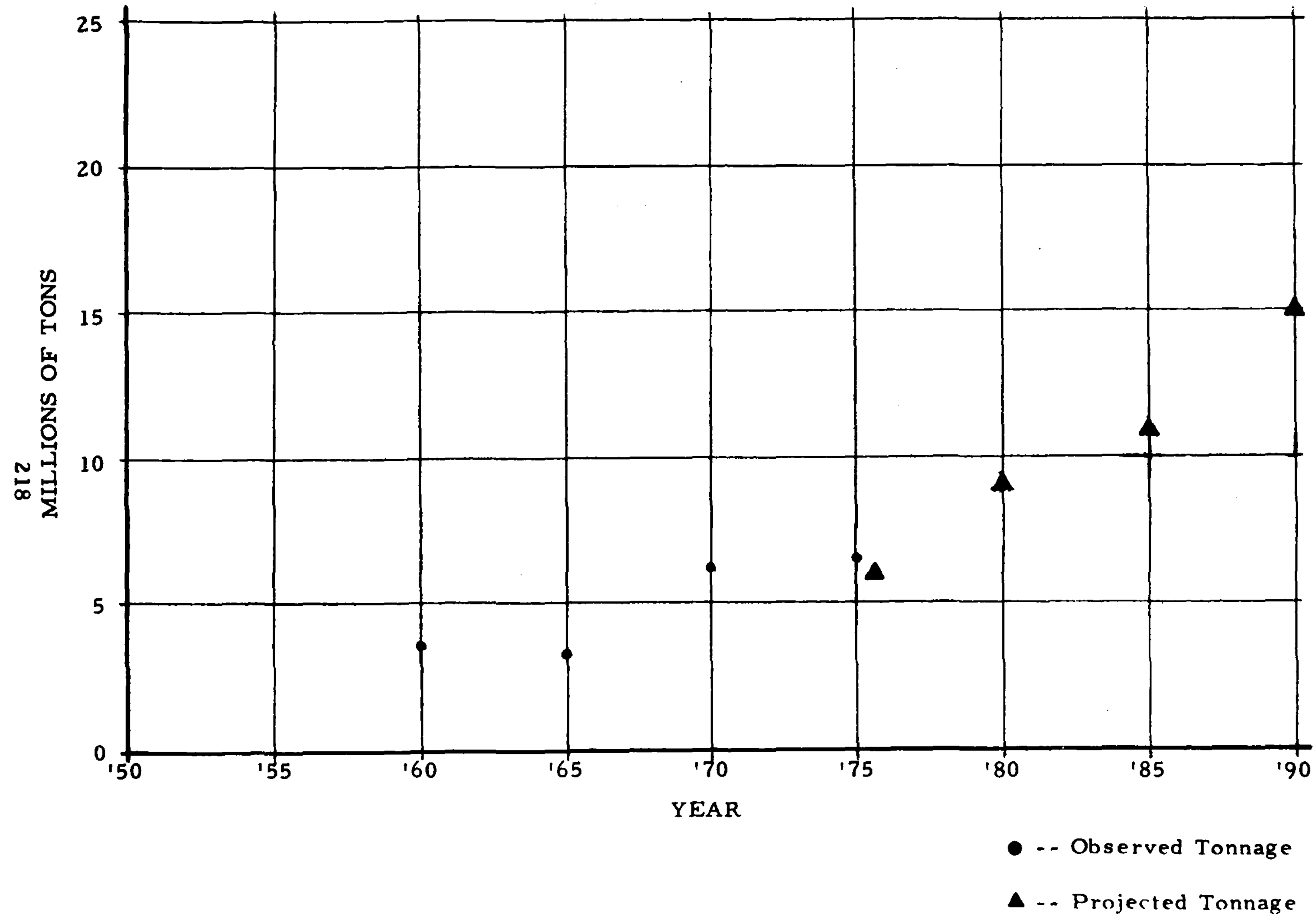
Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	1,719	745	974	2,190	917	1,273	3,039	1,257	1,782	4,119	1,711	2,408
2	752	685	67	1,099	974	125	1,542	1,312	230	2,151	1,736	415
4	11	0	11	15	0	15	17	0	17	21	0	21
5	1,327	1,280	47	895	869	26	1,017	988	29	1,140	1,112	28
6	1,339	1,261	78	1,709	1,573	136	2,455	2,273	182	3,410	3,169	231
7	215	186	29	442	366	76	644	493	151	950	661	289
8	272	209	63	434	329	105	557	408	149	727	506	221
9	1,276	780	496	1,841	1,056	785	2,432	1,348	1,084	3,126	1,666	1,460
3	3	0	3	0	0	0	0	0	0	0	0	0
Total	6,914	5,146	1,768	8,625	6,084	2,541	11,703	8,079	3,624	15,644	10,571	5,073

Base Year Assignment** = 6,655

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Wheeler L&D (mile 274.9)



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Guntersville L&D (Tenn. R.) (mile 349.0)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	1,068	252	816	1,476	385	1,091	2,173	620	1,553	3,091	963	2,128
2	530	518	12	772	750	22	1,068	1,027	41	1,461	1,387	74
4	70	9	61	113	10	103	158	9	149	204	7	197
5	1,043	1,020	23	752	740	12	866	853	13	993	979	14
6	335	293	42	466	409	57	644	564	80	862	753	109
7	186	185	1	364	362	2	493	489	4	663	657	6
8	207	167	40	339	267	72	444	334	110	590	413	177
9	903	663	240	1,188	836	352	1,547	1,068	479	1,959	1,323	636
3	3	0	3	0	0	0	0	0	0	0	0	0
Total	4,345	3,107	1,238	5,470	3,759	1,711	7,393	4,964	2,429	9,823	6,482	3,341

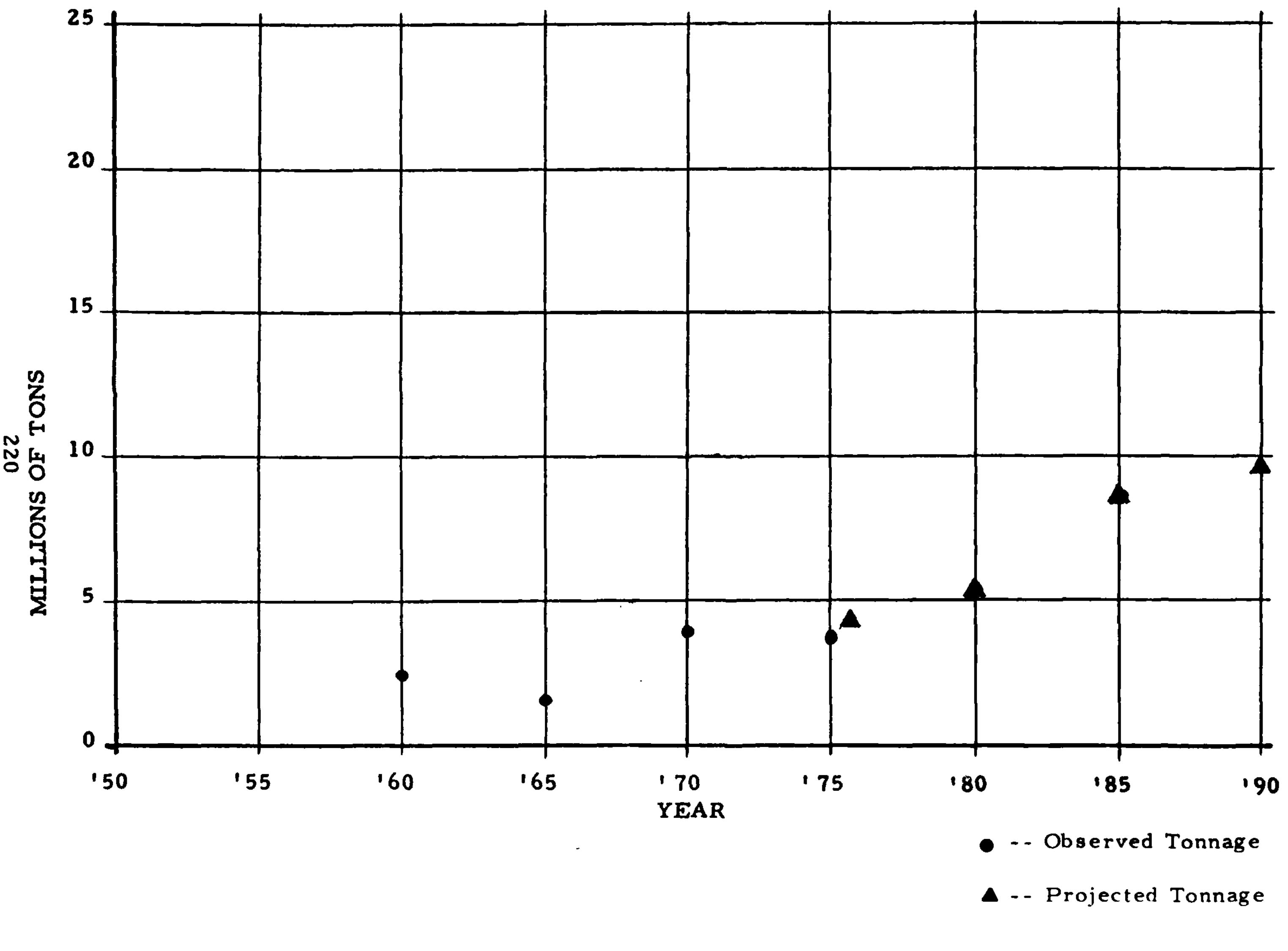
Base Year Assignment** = 4,361

*Thousands of tons.

**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Guntersville



Revised 1/79

PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Nickajack L&D (Tenn. R.) (mile 424.7)

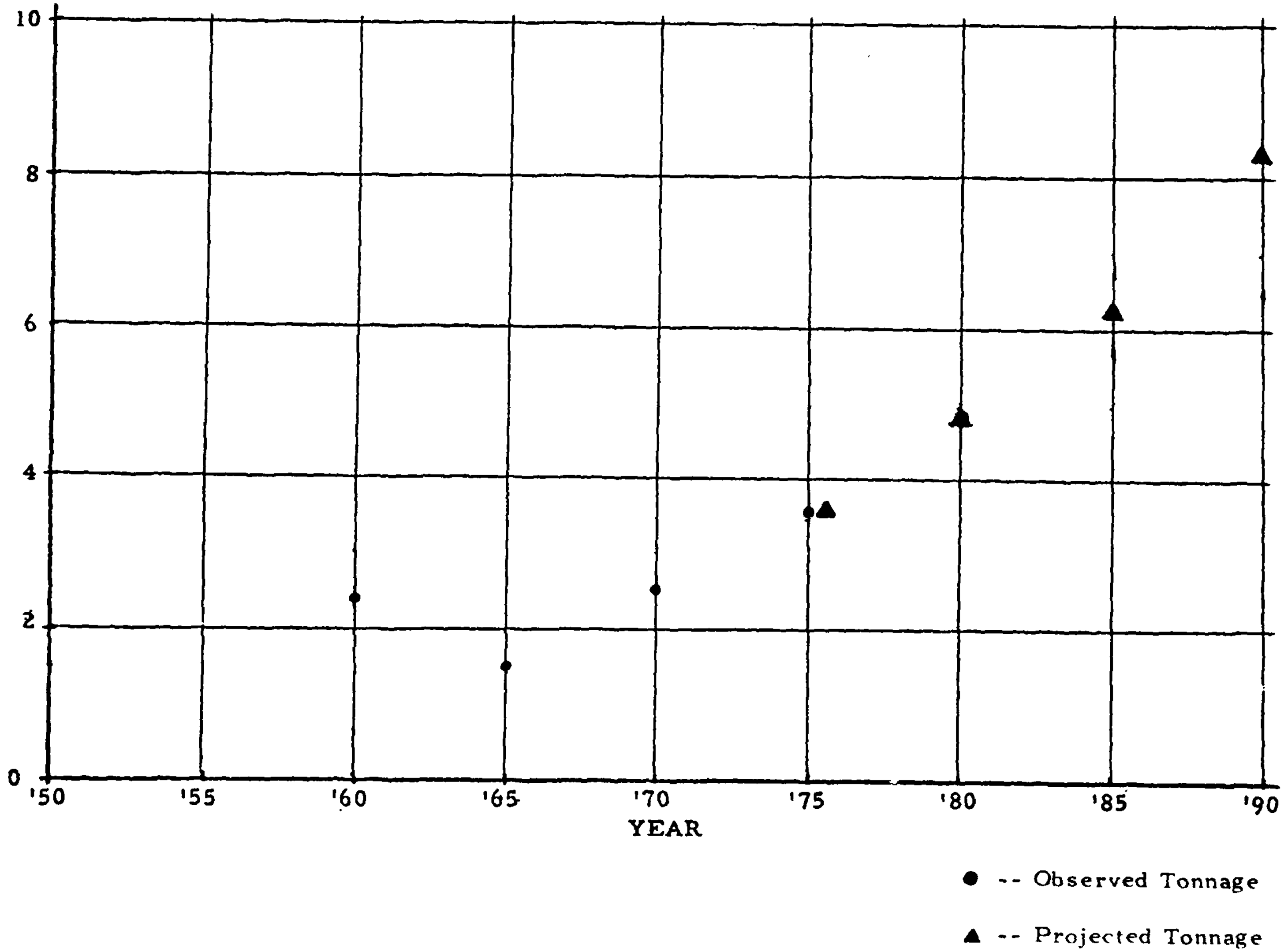
Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	**1,062**	**246**	**816**	1,469	378	1,091	2,165	611	1,554	3,080	953	2,127
2	**458**	**458**	**0**	663	663	0	913	913	0	1,236	1,236	0
4	**392**	**376**	**16**	497	481	16	548	536	12	598	587	11
5	**671**	**665**	**6**	453	451	2	545	543	2	661	659	2
6	**121**	**85**	**36**	120	77	43	158	98	60	206	122	84
7	**184**	**183**	**1**	362	360	2	491	488	3	661	655	6
8	**114**	**93**	**21**	185	148	37	243	192	51	320	244	76
9	**854**	**684**	**170**	1,029	822	207	1,330	1,062	268	1,678	1,338	340
3	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total	**3,856**	**2,790**	**1,066**	4,778	3,380	1,398	6,393	4,443	1,950	8,440	5,794	2,646

Base Year Assignment** = 3,757

*Thousands of tons.
**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Nickajack L&D (mile 424.7)



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Chickamagua L&D (Tenn. R.) (mile 471.0)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	263	263	0	416	416	0	705	705	0	1,184	1,184	0
2	148	148	0	206	206	0	272	272	0	357	357	0
4	5	5	0	4	4	0	5	5	0	5	5	0
5	13	13	0	36	35	1	69	68	1	135	134	1
6	48	20	28	54	22	32	67	22	45	87	24	63
7	184	183	1	362	360	2	491	488	3	661	655	6
8	20	4	16	30	5	25	37	6	31	44	7	37
9	330	312	18	367	345	22	480	451	29	620	577	43
3	0	0	0	0	0	0	0	0	0	0	0	0
Total	1,011	948	63	1,475	1,393	82	2,126	2,017	109	3,093	2,943	150

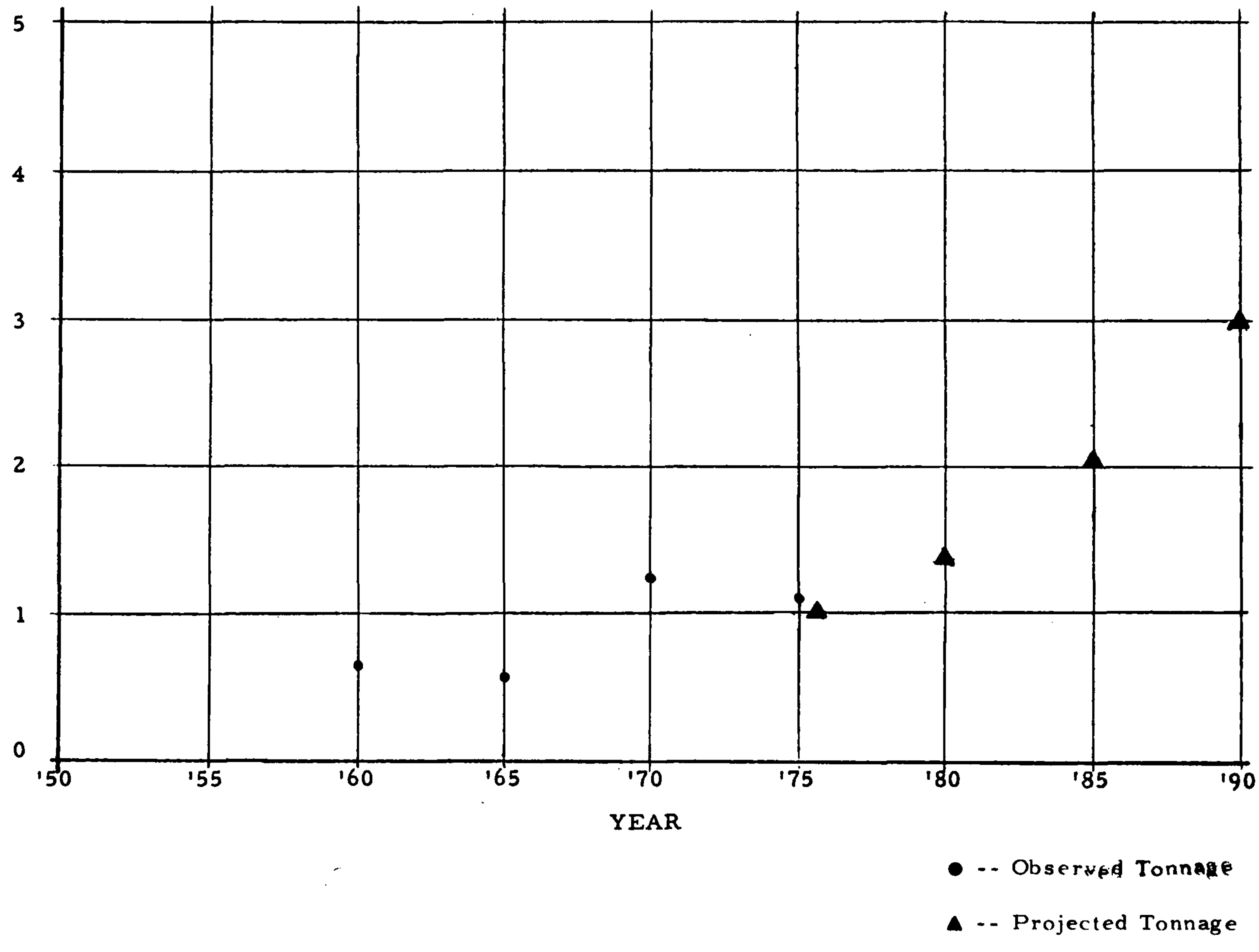
Base Year Assignment** = 1,005

*Thousands of tons.

**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Chickamagua L&D (mile 471.0)



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Watts Bar L&D Tennessee River (mile 529.9)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	263	263	0	0			0			0		
2	34	34	0	38	38	0	40	40	0	41	41	0
4	10	10	0	11	11	0	8	8	0	8	8	0
5	13	13	0	36	35	1	69	68	1	135	134	1
6	14	14	0	15	15	0	12	12	0	9	9	0
7	103	102	1	211	209	2	308	304	4	449	443	6
8	20	4	16	30	5	25	37	6	31	44	7	37
9	187	111	76	209	123	86	256	149	107	299	171	128
3	0	0	0	0	0	0	0	0	0	0	0	0
Total	644	551	93	550	436	114	730	587	143	985	813	172

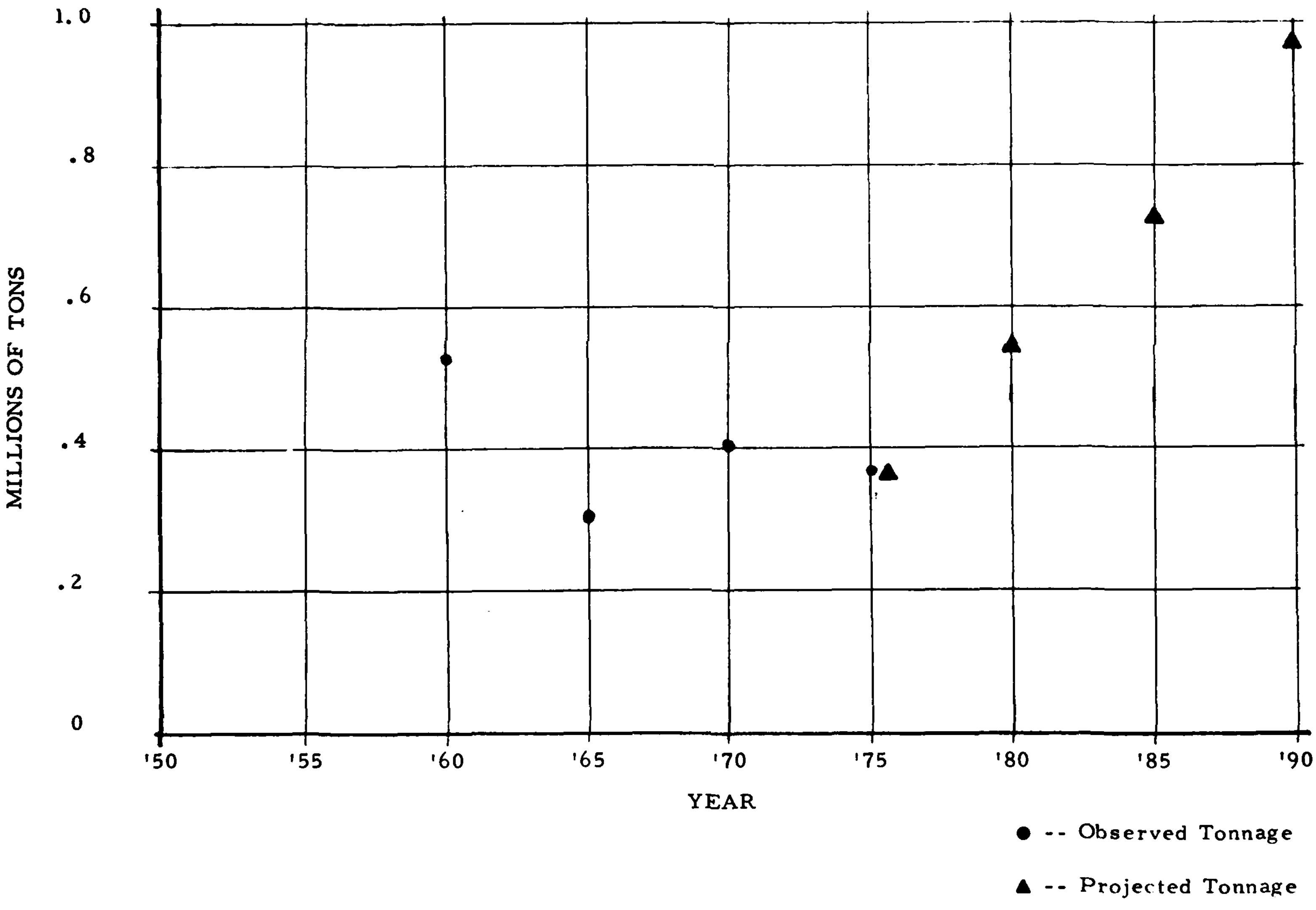
Base Year Assignment** = 385

*Thousands of tons.

**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Watts Bar L&D (mile 529.9)



PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Fort London L&D Tennessee River (mile 602.3)

Commodity Group	Observed 1976 Traffic			1980			1985			1990		
	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	0	0	0	0			0			0		
2	35	35	0	38	38	0	40	40	0	41	41	0
4	10	10	0	11	11	0	8	8	0	8	8	0
5	13	13	0	35	35	0	69	69	0	134	134	0
6	14	14	0	15	15	0	12	12	0	9	9	0
7	6	6	0	12	12	0	15	15	0	19	19	0
8	16	1	15	25	2	23	31	2	29	37	2	35
9	112	109	3	176	124	52	215	149	66	249	171	78
3	0	0	0	0	0	0	0	0	0	0	0	0
Total	206	188	18	312	237	75	390	295	95	497	384	113

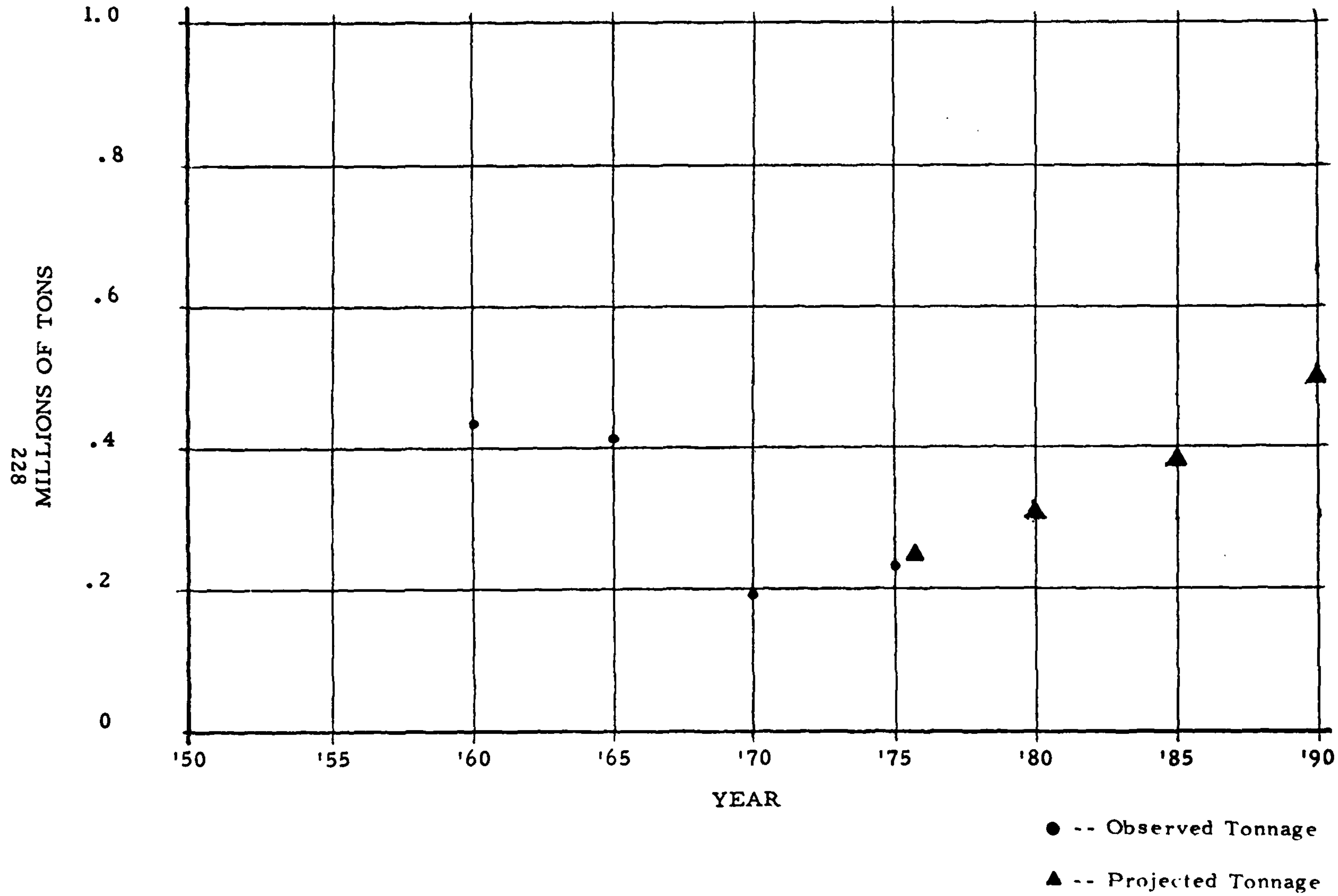
Base Year Assignment** = 255

*Thousands of tons.

**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

Revised 1/79

Fort Loudon L&D (mile 602.3)



PROJECTED LOCK AND DAM TRAFFIC

CLINCH RIVER

PROJECTED LOCK AND DAM TRAFFIC, BY COMMODITY GROUP AND DIRECTION*

Clinch River

Melton Hill L&D (mile 23.4)

Com-	Observed 1976 Traffic			1980			1985			1990		
modity Group	up + down	up	down	up + down	up	down	up + down	up	down	up + down	up	down
1	0			0			0			0		
2	0			0			0			0		
4	0			0			0			0		
5	0			0			0			0		
6	0			0			0			0		
7	0			0			0			0		
8	0			0			0			0		
9	3		3	4	0	4	5	0	5	5	0	5
3	0			0			0			0		
Total	3		3	4	0	4	5	0	5	5	0	5

Base Year Assignment** = 3

*Thousands of tons.

**Commodity groups 5 and 6 use 1975 as base year; others use 1976.

4.0 CONCLUSIONS

The methodologies employed by CONSAD in projecting future demand for waterway commodity flows have all utilized historic traffic patterns to predict the future trends. One should realize that changes in either the physical characteristics of the system (e.g., new and/or improved navigation projects) or the competitive relationship between water, rail and pipeline shipping rates, could cause significant changes in the tonnages of commodities moving on the waters of the Ohio River Basin.

In addition, the projected totals for each commodity group depended on the OBERS Series E projections for population, personal income, and earnings of certain key industries. If these projections turn out to be overly optimistic then the commodity group demand forecasts derived from them probably will not be reached.

Overall, the CONSAD analysis projects demand for future system traffic at a little over 328 million tons in 1990. This can be compared with just under 170 million tons of traffic moved in 1975. Table 69 presents total tonnage figures for five-year periods between 1945 and 1975, and the projected values for 1980, 1985, and 1990. Note that the average 5 year percent increase between 1945 and 1975 was 23 percent, quite comparable with the predicted 5-year percent increases between 1975 and 1990.

One might argue that the small increase in total tonnage between 1970 and 1975 represents a slowdown in the growth of waterborne commerce. However, the approximate 5 million ton increase between 1970 and 1975 includes a drop of over 6 million tons of crude petroleum shipments due to the opening of new pipelines. Thus, this special crude petroleum situation partially accounts for the small increase in total tons between 1970 and 1975.

It may well be that the recent apparent slowdown in the rate of increase of river traffic is due to the volume of river traffic approaching the capacity of the river system, i.e., the time required to ship by water may have increased due to the waiting times for use of lock facilities to the point where alternate modes of transport have become more competitive and thus more attractive. It should be noted that CONSAD has developed demand projections, and that capacity constraints were not used in any of

Table 69: Ohio River Basin Total Tonnage*

Year	Total Tons	% Increase
1945	51,262	
		28.9
1950	66,092	
		54.6
1955	102,167	
		3.1
1960	105,318	
		29.7
1965	136,596	
		20.0
1970	163,903	
		3.1
1975	168,991	
		26.4
1980	213,454	
		24.1
1985	264,717**	
		23.9
1990	327,989**	

*thousands of tons
**No crude petroleum

this work except to the extent that historic volumes reflected such constraints. If the capacity of current facilities has been responsible for a slowdown in the rate of increase of waterborne commerce, and continues to be so, one would not expect river traffic to reach the levels estimated in this study without improvement of facilities.

The assignment of commodity group tonnages to individual lock and dam projects was the result of systemwide projected commodity group totals being distributed among the individual originating and receiving ports according to the base year distribution modified by historical trends. This "system to component" approach seems reasonable in light of the analysis in Section 3.1.4 where a fairly strong degree of association was discovered between the system and its components. However, this does not bely the fact that certain commodities are moving in response to very different and/or more localized variables than those that were tested in this study. It is expected that such issues will be addressed in companion ORB traffic projection efforts.

APPENDIX A: Commodity Code Conversions

COMMODITY CODE CONVERSION: 1949-1964 3-digit to Standard 4-digit

552	2951	109	2049	260	0129
411	2431	110	2042	280	0121
725	3511	120	0141	285	2111
840	2851	123	2034	290	2062
525	3911	125	2034	297	0191
507	2911	127	2034	300	0101
521	2911	130	0131	310	2211
645	3411	132	0132	320	2311
415	2431	133	2039	324	2212
475	2691	135	2039	326	2212
005	0151	136	2039	328	2212
090	0151	137	2039	331	2311
010	2011	138	2039	335	2311
013	2012	140	0131	340	2015
017	2012	150	2091	350	2211
018	2012	160	0133	381	2823
020	2092	161	0134	390	2311
033	2021	165	2099	400	2411
035	2022	167	2099	401	2412
037	2021	170	2099	405	2414
039	2021	180	2061	408	2413
040	0911	185	2062	413	2421
043	2031	190	2081	416	2431
045	2031	195	2099	417	2491
047	2031	199	2094	421	2491
049	0912	200	0841	430	2491
050	0161	201	2822	440	2415
055	0913	203	4029	441	2611
060	0161	205	3011	445	4024
065	3111	207	3011	450	2621
075	0161	210	2861	457	2691
094	0931	220	0861	501	1121
095	0161	231	2091	502	1121
100	0103	232	0112	503	2991
101	0105	233	0119	504	2920
102	0102	234	0119	505	2911
103	0107	235	0119	506	2911
104	0104	236	0119	510	2914
107	2041	240	2091	511	1311
108	0106	250	2812	512	2912

Commodity Code Conversion: 1949-1964 3-digit to Standard 4-digit (continued)

513	2913
514	2915
516	2918
517	2916
518	2917
519	2916
520	2991
522	2911
523	3241
526	3281
530	3211
540	1451
543	3251
547	3251
548	1494
549	1492
550	1493
551	1411
553	1491
554	1442
555	1499
556	3312
600	1011
601	3311
602	4011
603	3314
605	3315
606	3411
607	3411
608	3317
609	3316
611	3411
612	3411
613	1061
614	3318
615	3318
617	1051
618	3324
620	1021
622	3322
624	3322
632	3322
640	1091
642	3323
652	1091
660	1091
662	3321
665	3321
670	1091
672	3323
682	3321
690	1091
700	3611
701	3611
710	3511
722	3511
730	3511
731	3511
740	3511
742	3511
745	3511
770	3511
780	3711
781	3711
782	3711
783	3731
785	3731
786	3791
787	3711
790	3721
793	3721
796	3791
801	2811
802	2817
805	2819
806	2819
810	2831
825	2818
826	2813
827	2810
828	2819
829	2819
846	2819
848	2851
849	2871
851	2871
852	1471
853	2873
854	2873
855	2872
859	2879
860	2891
862	2891
865	2841
900	3911
901	3911
920	3911
925	4111
926	2095
930	4029
940	4113
970	4118
999	9999
183	2062
325	2212
410	2414
420	2491
515	2916
604	3319
680	3321
720	3511
900	2811
830	2819
835	2818
845	2819
850	2871

COMMODITY CODE CONVERSION: 1948 3-digit to Standard 4-digit

661	2631
323	3251
001	0107
003	0103
007	0104
011	0105
013	0129
019	2049
023	2042
029	0121
031	2111
035	0101
043	0111
045	2034
075	0133
089	0129
091	2034
107	0191
199	0191
299	0161
305	1121
307	3313
309	1011
321	1091
327	1442
329	1442
333	1412
337	1311
339	2918
341	1491
343	1471
345	1492
399	1499
401	2411
407	2491
411	2421
413	2431
417	0861
479	0861
501	2911
503	2915
505	2916
507	2991
523	0841
527	2819
529	2818
531	2819
533	2810
535	2813
539	2879
543	2918
545	2812
547	2851
553	2831
565	3323
573	3311
575	3314
577	3315
579	3314
581	3319
583	3315
585	3319
587	3317
589	3791
591	3511
595	3511
597	3511
609	3791
611	3791
613	3711
615	3711
617	3511
623	3511
627	3711
629	1911
633	3241
639	3251
643	3291
653	2611
657	2621
659	2691
663	2691
665	2691
673	2691
685	3611
687	3911
691	3911
695	3211
697	3211
701	3911
703	2491
705	3911
707	3911
711	3911
713	3911
715	3911
723	2823
725	2823
727	2211
743	3911
749	2081
751	2094
755	2099
759	2061
763	2094
769	2841
771	3911
773	2042
779	3319
785	2491
787	2491
789	4011
793	3312
797	4029
799	3911
798	3731
693	3211

COMMODITY CODE CONVERSION: 1943-1947 3-digit to Standard 4-digit

699	3211
703	4112
353	3281
010	0107
020	0103
030	0104
040	0102
041	0105
060	2049
061	2049
091	0101
101	0101
143	0104
150	2034
152	2034
164	0191
221	2021
222	2014
282	0161
300	1121
310	3313
350	1442
351	1442
352	1412
360	1311
380	1491
391	1492
392	1499
400	2411
410	2491
430	2421
431	2431
443	0861
450	2914
451	2915
452	2916
453	2991
460	0119
470	2061
471	2099
490	3311
491	3314
500	3315
511	3317
512	3319
513	3315
522	3323
530	3511
540	3241
560	3271
580	3511
590	3711
591	3711
611	2511
620	2081
640	2879
650	2621
651	2491
660	2813
661	2818
670	2211
671	2823
680	2094
690	2111
691	2851
692	3312
693	4011
694	2691
695	2631
696	2691
698	2841
700	3211
701	3911
704	3319
702	3319
080	0121
090	0101
100	0129
161	0129
260	2211
280	2031
320	1011
401	2414
432	2431
593	3711
042	0129
370	2918
390	1471
440	0861
442	0841
461	0119
462	2091
472	2062
510	3317
521	3322
523	3324
582	3511
592	3711
610	2511
333	1091
420	2691
043	2099
551	3251
552	1499
581	3791

APPENDIX B: Individual
River Data Set

Table B. 1: Individual River Tonnages by Commodity Group and Direction - Ohio River - Up

	Coal and Coke	Petroleum Fuels	Crude Petroleum	Aggregates	Grains	Chemical and Chemical Fertilizers	Ores and Minerals	Iron Ore and Iron and Steel	All Other
1940	509366.	1081895.	1070807.	1273347.	83126.	11170.	80701.	262667.	106885.
1941	466212.	1511101.	1530953.	1417728.	101240.	11620.	129871.	548886.	193209.
1942	523864.	1609577.	1222635.	1810938.	110427.	8845.	181061.	418635.	148510.
1943	805785.	1321398.	1182823.	1507083.	139549.	7213.	108912.	421757.	114798.
1944	669785.	1481152.	1383559.	1111857.	192051.	62294.	204086.	389222.	94001.
1945	631581.	1489052.	1576397.	1127879.	148972.	92826.	164589.	337960.	166433.
1946	564813.	1597314.	1435835.	1675430.	80851.	47844.	129285.	307520.	157468.
1947	898854.	1741913.	1469381.	2253742.	75327.	23139.	175627.	357694.	143999.
1948	1403469.	2144472.	1619807.	2237819.	61211.	180308.	208870.	373558.	100049.
1949	2080667.	2584916.	1432704.	1627841.	90795.	274281.	337125.	231881.	90184.
1950	3395036.	3201050.	1593324.	1872853.	123798.	403610.	252128.	287866.	149559.
1951	3727399.	3428531.	1979424.	2658143.	126222.	488388.	267883.	217258.	127197.
1952	4022528.	3838354.	1777108.	2678437.	152303.	376962.	264446.	419196.	186312.
1953	4452911.	4114684.	1666704.	2236917.	268489.	371332.	311856.	516327.	290842.
1954	4081177.	3716925.	2098688.	2119101.	294149.	331349.	333340.	222424.	355157.
1955	7245210.	3918462.	2134514.	2656016.	417975.	469394.	451082.	523550.	535187.
1956	8022800.	3816826.	2429242.	2865859.	282621.	556712.	461748.	609960.	543603.
1957	7161196.	4203814.	3599692.	2813633.	653482.	599233.	507627.	326154.	700411.
1958	6593746.	4168841.	3461959.	2289301.	1227409.	668448.	498901.	341735.	993003.
1959	8022268.	4376732.	3572588.	2039692.	1273428.	760117.	506525.	332224.	985416.
1960	7535022.	4536422.	2246630.	2181647.	1454673.	990808.	484288.	582655.	1181677.
1961	7450364.	4868856.	2057848.	2190559.	7684.	916241.	489673.	376407.	659290.
1962	7604395.	5000777.	2455193.	3021002.	2084280.	1023447.	594205.	381449.	1140906.
1963	8200844.	5133513.	3170539.	3792658.	1549899.	1221778.	833701.	407112.	1162924.
1964	7929724.	5076034.	3814286.	4130826.	1242790.	1368427.	985330.	363842.	1265951.
1965	8526401.	5186936.	3611177.	3392534.	1466162.	1639836.	1263666.	305923.	1260489.
1966	8024762.	5215478.	3857703.	5130073.	1930735.	1809486.	1431787.	396132.	1441926.
1967	9411558.	5248225.	3526867.	4304069.	1847390.	2055564.	1707072.	425518.	1439844.
1968	10433177.	5177659.	4548131.	4678683.	1546294.	2377771.	1979768.	480790.	2442791.
1969	11636373.	5364504.	6504549.	5427763.	2307500.	2882072.	1996903.	660193.	2415785.
1970	10950064.	5481449.	6863758.	5173384.	2633272.	2804482.	2180292.	807611.	2416396.
1971	12185695.	5675453.	7783357.	5377125.	2694260.	2832173.	2380704.	717880.	2076584.
1972	13190246.	5802950.	7636072.	5276499.	1721426.	2975639.	1812471.	1034007.	1800665.
1973	12854643.	5987219.	4060070.	4648493.	1637616.	2357380.	1553791.	954588.	2435599.
1974	12994418.	6531835.	199774.	4727529.	1582939.	3122532.	1495092.	1029962.	1872424.
1975	14277854.	6790247.	196469.	4290744.	1215764.	2483008.	1340304.	795068.	1851579.

Table B. 2: Individual River Tonnages by Commodity Group and Direction - Ohio River - Down

	Coal and Coke	Petroleum Fuels	Crude Petroleum	Aggregates	Grains	Chemical and Chemical Fertilizers	Ores and Minerals	Iron Ore and Iron and Steel	All Other
1940	2916936.	450085.	0.	2465964.	150.	60854.	2666.	573845.	260840.
1941	3558971.	515063.	0.	3164695.	1212.	59507.	3840.	345318.	315813.
1942	4370187.	183348.	0.	3032498.	500.	88735.	4214.	289353.	401415.
1943	4187819.	126882.	109248.	1872573.	0.	119452.	1923.	336193.	195817.
1944	4729323.	115467.	1400.	1708301.	0.	140881.	3655.	468501.	237861.
1945	4146339.	288267.	0.	2044838.	360.	47589.	65.	428417.	227947.
1946	4355280.	422677.	0.	3449728.	0.	66920.	30.	343073.	301962.
1947	5029008.	659355.	3340.	3112709.	2994.	72817.	750.	377072.	243565.
1948	5909997.	811082.	5122.	3429363.	0.	71521.	742.	425222.	233439.
1949	4217352.	1085761.	12369.	3732888.	7930.	127180.	87112.	520429.	96250.
1950	4688266.	1390779.	11163.	3823789.	10805.	192416.	91672.	749580.	195326.
1951	5305322.	1501750.	2012.	4688793.	16261.	250553.	179796.	752539.	120689.
1952	4946773.	1382694.	11431.	4980563.	0.	290606.	230980.	718003.	274104.
1953	6664205.	1306965.	10141.	4273983.	21360.	393335.	155767.	974879.	348854.
1954	7634967.	1223837.	11856.	4347077.	837.	366046.	148521.	1240729.	176213.
1955	9889652.	1274167.	7188.	4638069.	21219.	490341.	320619.	1453366.	325821.
1956	10222833.	1411319.	17725.	4797849.	32103.	555019.	301354.	1388361.	864949.
1957	10744801.	1799506.	6213.	4762259.	9737.	727884.	297470.	1467183.	787074.
1958	10706532.	1660559.	16915.	4424180.	2114.	649826.	284597.	997440.	1074272.
1959	10867806.	1931364.	63763.	5911025.	3184.	640746.	32743.	1252272.	1020160.
1960	9122429.	1651126.	71372.	5654027.	600.	607733.	34203.	1052339.	1298413.
1961	8449803.	1561580.	81125.	5899241.	1457550.	739056.	54295.	846496.	1433395.
1962	9063959.	1478051.	2535.	5469864.	2709.	732894.	36680.	939262.	1284675.
1963	8390383.	1696308.	0.	5963453.	5713.	679364.	14113.	975853.	1671008.
1964	8158957.	1770502.	13323.	6615333.	2856.	795312.	30030.	964403.	1787533.
1965	7506261.	2232532.	16073.	7302850.	5386.	998778.	57502.	1022470.	3303346.
1966	9159311.	1823038.	2464.	6823614.	5570.	1177783.	17547.	763675.	3288756.
1967	11438075.	2172404.	2218.	7185433.	11858.	1524408.	15795.	852165.	3350869.
1968	13198721.	2111926.	2359.	7171722.	10035.	1393318.	25944.	928991.	2491296.
1969	14761320.	2305225.	29474.	7333843.	30496.	1355548.	19734.	950155.	2479412.
1970	14759584.	2203467.	23998.	6424162.	35746.	1566579.	18896.	1442054.	2704202.
1971	17331624.	2566140.	0.	7619421.	124393.	1691168.	53010.	1067315.	3022211.
1972	18838159.	3098908.	0.	6576999.	104797.	1396282.	34395.	1227281.	3237200.
1973	18556722.	3264022.	0.	7518435.	127595.	1014118.	108525.	1146831.	3284339.
1974	21309437.	3068226.	43668.	7430304.	150776.	1161202.	295977.	1247630.	4405530.
1975	21165105.	3045880.	121109.	6383708.	171323.	922276.	147795.	975314.	4230601.

Table B.3: Individual River Tonnages by Commodity Group and Direction - Ohio River - Else

	Coal and Coke	Petroleum Fuels	Crude Petroleum	Aggregates	Grains	Chemical and Chemical Fertilizers	Ores and Minerals	Iron Ore and Iron and Steel	All Other
1940	[illegible]	1294703.	86779.	1811184.	23445.	112477.	97383.	1133898.	595658.
1941	[illegible]	1851480.	135248.	2423956.	54890.	149769.	96971.	1258589.	1109850.
1942	[illegible]02.	1961832.	1203593.	2157298.	28130.	149898.	92505.	898453.	722914.
1943	15207302.	2854958.	1921180.	1575378.	39001.	294471.	98793.	1037392.	800385.
1944	15615736.	3149193.	2497926.	1139037.	12790.	560107.	97256.	775634.	912012.
1945	13679613.	2780093.	2170507.	1091265.	4598.	355259.	81410.	336052.	449511.
1946	13598981.	2450533.	2146685.	1846708.	2307.	161731.	63268.	308303.	336868.
1947	16482945.	2757650.	2217772.	2116114.	9935.	170011.	123237.	518218.	359514.
1948	14916151.	3243954.	2428523.	2318293.	31128.	221547.	104854.	587504.	619523.
1949	12798359.	3031430.	2490035.	2043248.	9906.	381228.	217223.	751549.	539812.
1950	15776684.	3797408.	1598781.	2555866.	34372.	410963.	246461.	1093896.	650357.
1951	19538806.	4475653.	946639.	2919076.	58442.	813920.	227117.	990532.	732852.
1952	17371389.	4641801.	1382424.	2973002.	79387.	700121.	222111.	1264145.	772187.
1953	20613613.	4649055.	1292643.	2947822.	94286.	812159.	542053.	1825718.	877403.
1954	14337061.	4763031.	917448.	2540735.	105847.	616282.	305094.	1898401.	890385.
1955	20828075.	5420957.	723151.	2664145.	204320.	689285.	461512.	2389101.	1308800.
1956	23169581.	5939541.	479972.	2185182.	276212.	798039.	538525.	2694032.	1214666.
1957	26749039.	5370144.	36343.	2061219.	295181.	835876.	482210.	2757833.	1808038.
1958	20717712.	5072357.	152096.	2490910.	198654.	859053.	464050.	1973288.	1486938.
1959	22005040.	5655932.	110709.	2488147.	485071.	1480830.	810458.	2281981.	1885387.
1960	23246662.	5365900.	1272386.	2304314.	541729.	1746885.	773052.	2128860.	1412014.
1961	24731879.	5573642.	1671427.	1940075.	360295.	2027643.	928090.	2011968.	1353927.
1962	25258707.	5698725.	1620295.	3222843.	431834.	2266191.	1154789.	1520754.	1815115.
1963	26025010.	5881943.	1202898.	2882624.	676252.	2614406.	1418685.	1548953.	1705079.
1964	30582670.	6303136.	529336.	3609594.	826022.	3043341.	1592711.	1731341.	1838498.
1965	32573151.	6174930.	978875.	3833034.	1064364.	3325884.	1438145.	2110481.	2576616.
1966	34766927.	5866970.	1189232.	4210189.	987427.	3613412.	1901001.	1959078.	2824744.
1967	33550816.	5929358.	1577307.	4445364.	1284635.	3992568.	1832851.	1808904.	2511288.
1968	32590527.	7039175.	1232874.	5964057.	1228663.	4553244.	1695218.	1843159.	3058134.
1969	32466088.	6967724.	59098.	5779467.	898268.	5344334.	1415260.	1636199.	3226312.
1970	33301199.	7785557.	202339.	5649807.	673821.	6204310.	1686955.	2132140.	3451434.
1971	26540905.	8098335.	173168.	5906276.	1190650.	6616680.	1978867.	1860024.	3801677.
1972	33360732.	8636058.	175008.	5931095.	1297177.	6609639.	1698786.	2163584.	3321573.
1973	34157991.	8572303.	140317.	6310679.	1220002.	6333508.	1336373.	2447655.	3210608.
1974	33455368.	9276864.	400460.	6269698.	1595402.	6922156.	1938053.	2467732.	4299250.
1975	37857756.	8917348.	549475.	5817195.	2682183.	5664503.	1945418.	2126451.	4093846.

Table B. 4: Individual River Tonnages by Commodity Group and Direction - Monongahela River - Up

	Coal and Coke	Petroleum Fuels	Crude Petroleum	Aggregates	Grains	Chemical and Chemical Fertilizers	Ores and Minerals	Iron Ore and Iron and Steel	All Other
40	246439.	225298.	0.	1217979.	202.	10826.	50203.	819480.	35295.
41	447132.	308939.	0.	1702910.	0.	21510.	78153.	1059131.	86711.
42	717438.	420742.	0.	1545242.	413.	18551.	129409.	891232.	49526.
43	962995.	363845.	0.	1366432.	939.	60157.	44856.	916264.	43911.
44	1020674.	372290.	0.	917117.	0.	156582.	144080.	728584.	80050.
45	766002.	374351.	0.	919077.	0.	110106.	118811.	350258.	91054.
46	727791.	476196.	0.	1575882.	0.	12549.	81506.	344180.	57108.
47	572237.	426731.	0.	1754193.	0.	18689.	127428.	475970.	23990.
48	1194532.	426359.	0.	2095484.	0.	13223.	128872.	462871.	45513.
49	2051444.	527829.	0.	1876130.	0.	9712.	85986.	424171.	25392.
50	1516539.	638191.	0.	2190290.	0.	19118.	127770.	541569.	34542.
51	3237270.	695504.	0.	2459721.	0.	2205.	162508.	421702.	27841.
52	2354424.	1132135.	0.	2328768.	0.	11673.	480421.	582164.	49085.
53	1744942.	1138707.	0.	2169939.	0.	20987.	633759.	678533.	26472.
54	1118064.	756732.	0.	2027656.	0.	22481.	502725.	772127.	45177.
55	2303006.	870187.	1258.	2063866.	0.	22871.	644256.	1018929.	38724.
56	2415265.	1125033.	0.	1904445.	0.	30767.	714380.	952549.	54845.
57	2501545.	1107988.	0.	1617359.	0.	32559.	692852.	1108667.	64571.
58	1749588.	872887.	4036.	1910618.	0.	21810.	548118.	709981.	77526.
59	1421364.	933745.	40522.	1752333.	0.	34374.	125125.	821173.	383630.
60	1654584.	1062656.	0.	1457557.	0.	55131.	120715.	853095.	596562.
61	2472595.	1053735.	0.	969433.	0.	97816.	130121.	671445.	280692.
62	2505594.	994648.	21300.	1615551.	0.	87415.	95105.	833062.	267615.
63	2822339.	1177764.	0.	1516797.	0.	126912.	144724.	859291.	166160.
64	4125615.	1185011.	4741.	1842934.	0.	93751.	214518.	971094.	192333.
65	4029212.	1139367.	19083.	1893557.	0.	165860.	300134.	985980.	219405.
66	5869502.	978515.	7060.	1803839.	0.	204137.	301523.	1092509.	284982.
67	5665119.	1045869.	0.	1541875.	0.	256485.	403800.	970822.	239407.
68	5387478.	1114447.	0.	1921048.	0.	347550.	393514.	1128330.	311310.
69	4711168.	1162021.	22466.	1959848.	0.	364074.	428502.	1195697.	300229.
70	4298673.	1249634.	0.	1563544.	0.	382454.	722756.	1207776.	216728.
71	4480874.	1328048.	0.	1525299.	0.	338351.	1077391.	1141821.	281618.
72	4158889.	1649422.	0.	1478343.	0.	165118.	761393.	1445557.	249209.
73	4341187.	[illegible]77419.	0.	1599385.	0.	103823.	442666.	1239504.	298860.
74	4170481.	2[illegible]35279.	0.	1561381.	0.	124638.	322078.	896625.	328226.
75	5598306.	2173557.	0.	1322449.	0.	78863.	368034.	558812.	309859.

Table B.5: Individual River Tonnages by Commodity Group and Direction - Monongahela River - Down

	Coal and Coke	Petroleum Fuels	Crude Petroleum	Aggregates	Grains	Chemical and Chemical Fertilizers	Ores and Minerals	Iron Ore and Iron and Steel	All Other
40	25846561.	100248.	0.	68839.	0.	278675.	0.	518753.	81365.
41	26314814.	111550.	0.	65276.	0.	309207.	11708.	574566.	153321.
42	28897769.	25815.	0.	234358.	0.	307529.	0.	374077.	170637.
43	25783256.	54449.	0.	228229.	0.	275700.	0.	484495.	175654.
44	26094901.	24197.	0.	116943.	0.	430004.	116.	498027.	144904.
45	22729844.	111478.	0.	189597.	0.	330018.	0.	376931.	65869.
46	21214273.	55024.	0.	148096.	0.	204436.	0.	330197.	126701.
47	27137859.	162392.	0.	165920.	0.	282373.	0.	438850.	45522.
48	24383988.	101809.	0.	132013.	0.	297719.	0.	515873.	141828.
49	18810445.	152314.	0.	138846.	0.	309976.	45091.	646533.	43129.
50	21487973.	134566.	0.	205495.	0.	357675.	43881.	931243.	130219.
51	23229645.	144373.	0.	210930.	0.	368815.	100890.	766591.	70913.
52	19703450.	115367.	1106.	145905.	0.	337888.	66759.	612879.	14538.
53	25010746.	111073.	1786.	182732.	0.	453297.	271281.	674882.	22753.
54	20647683.	174495.	0.	104802.	0.	417084.	57139.	2160006.	25049.
55	27897308.	243498.	7188.	217772.	0.	515227.	194643.	1426175.	20208.
56	27227189.	224921.	0.	33653.	0.	487038.	194277.	1453958.	24019.
57	28941066.	193124.	0.	9678.	0.	508534.	103039.	1410759.	11476.
58	21357928.	137354.	0.	5728.	0.	380144.	74949.	936036.	33822.
59	19919749.	123686.	0.	11516.	0.	327286.	12693.	1087877.	65976.
60	22085360.	125720.	0.	4636.	0.	341313.	16655.	968657.	86463.
61	19537784.	65027.	0.	128314.	0.	392821.	20978.	877773.	56335.
62	19765569.	10716.	0.	274800.	0.	367396.	26593.	835484.	56019.
63	22991346.	9627.	0.	244615.	0.	402924.	14537.	783923.	64589.
64	27429817.	14139.	0.	371936.	0.	495019.	7160.	789116.	74971.
65	28219694.	24102.	0.	239179.	0.	381903.	1413.	946775.	224551.
66	27215509.	23264.	0.	534979.	0.	416457.	6394.	723823.	144333.
67	28440293.	14709.	0.	491672.	0.	288285.	4158.	796554.	51265.
68	26455769.	18518.	0.	531135.	0.	331636.	4648.	863697.	183780.
69	27756358.	62212.	0.	633030.	0.	167537.	0.	821453.	312421.
70	30421871.	77524.	0.	434647.	0.	178461.	4445.	1333219.	192394.
71	23726251.	34051.	0.	440187.	0.	195235.	543.	850944.	249786.
72	26538949.	24409.	0.	619589.	0.	412585.	9088.	991950.	116462.
73	25474998.	37855.	0.	518500.	0.	301011.	28413.	1072608.	96375.
74	25850715.	55868.	2496.	447100.	0.	523941.	265898.	1168262.	112911.
75	24679362.	38550.	0.	585645.	0.	400941.	171005.	900527.	82451.

Table B.6: Individual River Tonnages by Commodity Group and Direction - Allegheny River - Up

	Coal and Coke	Petroleum Fuels	Crude Petroleum	Aggregates	Grains	Chemical and Chemical Fertilizers	Ores and Minerals	Iron Ore and Iron and Steel	All Other
40	701250.	114228.	0.	356407.	0.	0.	10030.	62384.	16433.
41	535516.	182571.	0.	503799.	0.	0.	29624.	84756.	16179.
42	487966.	260490.	5789.	303943.	0.	0.	10408.	4802.	44663.
43	540701.	195199.	15835.	241715.	0.	0.	11760.	51132.	37146.
44	464541.	296737.	0.	179554.	0.	0.	14465.	57316.	35245.
45	354983.	193705.	0.	158527.	0.	0.	8798.	40575.	39622.
46	422049.	120634.	0.	220069.	0.	0.	5488.	0.	45768.
47	464572.	117133.	0.	189318.	205.	0.	10261.	1415.	36425.
48	634876.	135906.	0.	242824.	0.	0.	2173.	6416.	43253.
49	505882.	119918.	0.	196330.	0.	0.	19680.	4250.	21891.
50	368586.	155089.	0.	318696.	0.	0.	14172.	59190.	52019.
51	591249.	160694.	1243.	390190.	0.	0.	21824.	102451.	44751.
52	362335.	151594.	0.	235092.	0.	0.	42080.	107873.	68928.
53	188348.	46021.	0.	274518.	0.	0.	61216.	195712.	49124.
54	46098.	66360.	0.	217318.	0.	0.	51246.	164785.	52441.
55	20383.	127974.	0.	400444.	0.	22534.	127607.	223931.	123230.
56	73022.	152959.	0.	225452.	0.	24234.	68382.	242774.	133639.
57	136622.	140713.	0.	219019.	0.	32435.	63147.	141978.	181987.
58	91813.	87723.	0.	263098.	0.	29587.	53332.	168028.	161143.
59	95680.	103884.	0.	227495.	0.	24587.	14626.	210345.	240721.
60	110364.	72206.	0.	190103.	0.	30123.	10311.	252332.	178512.
61	56766.	101574.	0.	106892.	2527.	22380.	18477.	241167.	205551.
62	160169.	238396.	0.	125197.	0.	15457.	10513.	143231.	169429.
63	220433.	167836.	0.	164019.	0.	39574.	47461.	190983.	213478.
64	411354.	195968.	0.	226121.	0.	36168.	76850.	216061.	284560.
65	337798.	242670.	0.	280365.	2857.	50332.	105881.	213948.	453557.
66	256519.	209760.	0.	263965.	0.	56475.	127515.	253949.	411327.
67	564172.	326614.	0.	243668.	0.	63243.	181908.	238392.	390183.
68	297179.	353444.	0.	275105.	0.	45071.	161376.	292015.	391533.
69	979466.	303512.	0.	199260.	0.	34746.	267451.	294235.	349934.
70	1414735.	309067.	0.	316725.	0.	54885.	225447.	137424.	328334.
71	1460538.	238821.	0.	450257.	0.	68135.	118349.	107152.	377922.
72	1302589.	214743.	0.	406582.	0.	110889.	161354.	163501.	351201.
73	1136232.	282018.	0.	154299.	0.	69996.	159552.	131577.	464094.
74	1408654.	311470.	1560.	55146.	0.	77366.	118547.	165636.	484943.
75	1000919.	243430.	0.	61306.	0.	99994.	115516.	210585.	432708.

Table B.7: Individual River Tonnages by Commodity Group and Direction - Allegheny River - Down

	Coal and Coke	Petroleum Fuels	Crude Petroleum	Aggregates	Grains	Chemical and Chemical Fertilizers	Ores and Minerals	Iron Ore and Iron and Steel	All Other
40	1029594.	51955.	0.	1534590.	0.	0.	0.	5815.	7676.
41	1048061.	30231.	0.	666010.	0.	0.	83196.	3409.	3910.
42	1084273.	10079.	0.	501269.	0.	0.	0.	2675.	4645.
43	1208909.	37668.	0.	570705.	0.	1203.	0.	1091.	1100.
44	1405800.	27072.	0.	262477.	0.	1365.	0.	398.	175.
45	1091267.	73459.	0.	393905.	0.	757.	0.	1081.	0.
46	868959.	30469.	0.	775676.	0.	767.	0.	126.	2079.
47	930111.	38514.	0.	823319.	0.	0.	699.	0.	384.
48	1164253.	30154.	0.	910576.	0.	0.	0.	3802.	1610.
49	1101863.	66021.	0.	865744.	0.	0.	1208.	16279.	1993.
50	1449140.	48226.	0.	1012411.	0.	1812.	0.	17050.	5867.
51	1512795.	31684.	0.	1279491.	0.	4024.	0.	16299.	3791.
52	1208234.	37191.	0.	1187552.	0.	9820.	7970.	15460.	1416.
53	1568265.	39129.	0.	1122039.	0.	6640.	5173.	30764.	3858.
54	1965077.	96516.	0.	1075900.	0.	1806.	728.	5718.	29081.
55	2601011.	11700.	1258.	924966.	0.	0.	1864.	18848.	27429.
56	2936152.	7997.	0.	1232943.	0.	1304.	490.	22443.	32111.
57	3034218.	29840.	0.	1186824.	0.	0.	800.	52318.	21235.
58	2437379.	45417.	0.	1149031.	0.	2250.	790.	16832.	44868.
59	1899504.	41654.	0.	1109657.	0.	772.	3472.	24723.	36906.
60	1951297.	19754.	0.	924288.	0.	1131.	19861.	21849.	50650.
61	2587348.	26709.	0.	955079.	0.	1153.	2264.	16464.	37215.
62	2646214.	20908.	0.	880682.	0.	0.	1195.	16683.	12930.
63	2600331.	22085.	0.	1053746.	0.	0.	2944.	13601.	10018.
64	2383791.	24386.	0.	984126.	0.	0.	2430.	15014.	9809.
65	2533094.	26286.	0.	1063759.	0.	0.	1208.	18911.	20495.
66	2594349.	23244.	0.	952226.	0.	0.	1208.	16865.	25853.
67	2112274.	16976.	0.	793713.	0.	0.	0.	17429.	26040.
68	1737999.	3340.	0.	1029297.	0.	0.	1207.	12869.	44582.
69	1822846.	18596.	0.	1323130.	0.	0.	0.	24933.	27511.
70	1476072.	37775.	0.	1312086.	0.	0.	0.	33675.	14922.
71	1302913.	48863.	0.	1714551.	0.	0.	0.	30516.	28148.
72	1367834.	43046.	0.	1250443.	0.	0.	2476.	16410.	34301.
73	1214818.	31564.	0.	1620341.	0.	0.	270.	17819.	34760.
74	1225615.	38155.	0.	1576071.	0.	1499.	0.	33344.	34046.
75	1609959.	51032.	0.	1493352.	0.	0.	2900.	10256.	30249.

Table B. 8: Individual River Tonnages by Commodity Group and Direction - Kanawha River - Up

	Coal and Coke	Petroleum Fuels	Crude Petroleum	Aggregates	Grains	Chemical and Chemical Fertilizers	Ores and Minerals	Iron Ore and Iron and Steel	All Other
40	35959.	127008.	86779.	338145.	0.	38151.	14806.	3232.	6658.
41	61411.	155956.	110467.	535080.	0.	48764.	18284.	5832.	113244.
42	196215.	148939.	117779.	458016.	0.	51604.	23714.	4431.	67280.
43	139153.	107652.	120374.	329170.	0.	76777.	25885.	4537.	77721.
44	183320.	110830.	147581.	187578.	0.	182751.	24476.	0.	65846.
45	137890.	168276.	169204.	148913.	0.	39869.	20128.	432.	237440.
46	108451.	195307.	122280.	313585.	0.	129281.	22133.	1292.	70399.
47	230978.	205089.	69361.	367265.	0.	99139.	22332.	4463.	41282.
48	387785.	191157.	103134.	361134.	0.	268833.	41766.	3734.	111540.
49	267264.	240371.	20555.	341126.	0.	336897.	173447.	2207.	9630.
50	370001.	306347.	0.	364616.	0.	500479.	158019.	3186.	11006.
51	282897.	408570.	0.	400235.	0.	557677.	118373.	2080.	17437.
52	241002.	410314.	0.	439387.	0.	458687.	121174.	0.	16201.
53	402694.	361546.	0.	500169.	0.	458007.	128764.	6826.	17336.
54	1022309.	335803.	0.	674520.	0.	387360.	177864.	7585.	2153.
55	1085733.	379850.	0.	279123.	0.	582705.	150177.	23027.	29758.
56	936716.	396004.	0.	430588.	0.	644458.	181985.	23191.	27832.
57	813904.	382713.	0.	453015.	0.	631370.	260747.	22236.	14049.
58	824623.	460029.	0.	477207.	0.	659086.	180347.	20375.	7696.
59	685215.	508190.	0.	505063.	0.	1445168.	147357.	7066.	103046.
60	952726.	443437.	0.	590143.	0.	1677854.	172728.	4446.	112747.
61	583320.	516652.	0.	675838.	0.	1798851.	321922.	12354.	134178.
62	382940.	566790.	0.	852879.	0.	1974615.	374710.	14241.	188105.
63	675631.	614220.	0.	784157.	0.	2330732.	392581.	34407.	144899.
64	1025246.	616571.	0.	590880.	0.	2607055.	481854.	3561.	65899.
65	1417566.	554458.	0.	650737.	0.	2822071.	236813.	27980.	350334.
66	1183237.	594007.	0.	657314.	0.	2718118.	327798.	35438.	379387.
67	1497548.	606670.	0.	677496.	0.	2969065.	304358.	7305.	349357.
68	957539.	634758.	0.	1083861.	0.	3510047.	315027.	6829.	342344.
69	256304.	708644.	0.	1137107.	0.	3482412.	241910.	20357.	325556.
70	552631.	779295.	0.	1159642.	0.	3502217.	286025.	15537.	277334.
71	994516.	800736.	0.	1665082.	0.	3637737.	340695.	14483.	246332.
72	940237.	871065.	0.	1615396.	0.	3403548.	206526.	12454.	133866.
73	1468859.	953632.	0.	1459441.	0.	3150312.	212248.	20322.	293411.
74	1152007.	937692.	1332.	1626276.	0.	3076264.	300753.	15850.	259973.
75	1376471.	1043581.	0.	1646994.	0.	2342550.	226926.	6835.	223449.

Table B. 9: Individual River Tonnages by Commodity Group and Direction - Kanawha River - Down

	Coal and Coke	Petroleum Fuels	Crude Petroleum	Aggregates	Grains	Chemical and Chemical Fertilizers	Ores and Minerals	Iron Ore and Iron and Steel	All Other
40	3714793.	133028.	0.	0.	0.	0.	0.	0.	895.
41	4438892.	177456.	0.	0.	0.	0.	0.	544.	1841.
42	4619743.	165857.	0.	0.	0.	0.	0.	0.	1501.
43	4025192.	137506.	0.	0.	0.	1529.	0.	0.	0.
44	3871103.	69351.	0.	0.	0.	1215.	0.	0.	0.
45	3502891.	74148.	0.	0.	0.	0.	0.	0.	0.
46	3380128.	155621.	0.	0.	0.	25702.	0.	0.	0.
47	4142362.	158670.	0.	0.	0.	25715.	0.	130.	598.
48	4153606.	189713.	0.	0.	0.	97179.	0.	0.	0.
49	3327629.	165238.	2534.	0.	0.	49926.	0.	2288.	17327.
50	4378049.	150685.	1119.	0.	0.	104937.	281.	2058.	36730.
51	4954438.	190437.	0.	0.	0.	151262.	0.	3005.	4949.
52	4848936.	183337.	0.	0.	0.	148075.	10029.	9060.	14176.
53	5043161.	206193.	12236.	0.	0.	226445.	25271.	6534.	27234.
54	3353195.	112276.	90468.	0.	0.	156237.	5224.	27301.	16721.
55	4725571.	39548.	42038.	0.	0.	163827.	45411.	74697.	22794.
56	5346899.	54212.	26589.	0.	0.	185257.	18538.	71003.	26349.
57	5856115.	49031.	28908.	0.	0.	252052.	14729.	74084.	29621.
58	5182441.	25265.	20760.	0.	0.	242098.	28281.	60545.	24391.
59	5731325.	49170.	7465.	0.	0.	229223.	10349.	41290.	44110.
60	5695974.	42460.	3387.	1666.	0.	287273.	11630.	38214.	45056.
61	5901528.	44459.	0.	6287.	0.	417360.	11089.	49006.	36738.
62	6241389.	31057.	4706.	0.	0.	431015.	2665.	37149.	36046.
63	6305623.	35119.	14188.	0.	0.	401364.	5076.	35472.	11252.
64	6577705.	38555.	7295.	1390.	0.	439951.	29566.	21986.	1940.
65	6517905.	57933.	14621.	8259.	0.	488578.	9991.	8129.	10010.
66	6661666.	29565.	2439.	10034.	0.	487043.	35305.	6844.	10009.
67	6556315.	35060.	0.	0.	0.	506621.	5247.	27792.	10519.
68	6638322.	28872.	0.	21903.	0.	510655.	18717.	28852.	10124.
69	6956690.	23558.	1231.	4441.	0.	610319.	16938.	42568.	21974.
70	6865548.	12503.	0.	2790.	0.	543785.	9809.	34103.	15455.
71	6516462.	21610.	0.	0.	0.	629992.	40969.	25433.	18319.
72	6500149.	10765.	0.	0.	0.	755754.	18360.	29346.	3750.
73	5887123.	16210.	0.	4159.	0.	619345.	43887.	15317.	25091.
74	4711675.	23571.	0.	8692.	0.	584233.	51727.	22703.	8278.
75	5058535.	41495.	0.	818.	0.	413171.	12477.	21382.	14740.

Table B. 10: Individual River Tonnages by Commodity Group and Direction - Kentucky River - Up

	Coal and Coke	Petroleum Fuels	Crude Petroleum	Aggregates	Grains	Chemical and Chemical Fertilizers	Ores and Minerals	Iron Ore and Iron and Steel	All Other
40	17794.	36327.	0.	179615.	0.	0.	0.	0.	0.
41	16002.	42795.	0.	205400.	0.	0.	0.	0.	0.
42	16702.	52492.	0.	224300.	0.	0.	0.	0.	0.
43	17926.	39617.	0.	171995.	0.	0.	0.	0.	0.
44	18546.	47970.	0.	109100.	0.	0.	0.	200.	0.
45	18735.	38204.	0.	90400.	0.	0.	0.	0.	0.
46	17557.	62850.	0.	36275.	0.	0.	0.	0.	0.
47	10294.	56764.	0.	6575.	0.	0.	0.	0.	0.
48	12855.	35423.	0.	8700.	0.	0.	0.	0.	0.
49	3863.	51867.	0.	11200.	0.	0.	0.	0.	0.
50	10390.	44876.	0.	9670.	0.	0.	0.	0.	0.
51	2203.	46800.	0.	11400.	0.	0.	0.	0.	0.
52	1571.	66456.	0.	3200.	0.	0.	0.	0.	750.
53	3796.	65596.	0.	2750.	0.	0.	0.	0.	0.
54	0.	66521.	0.	33223.	0.	0.	0.	0.	0.
55	0.	67124.	0.	53030.	0.	0.	0.	783.	129.
56	2348.	62041.	0.	66562.	0.	0.	0.	0.	0.
57	2291.	55385.	0.	101432.	0.	0.	0.	0.	0.
58	0.	56662.	0.	174267.	0.	0.	0.	0.	500.
59	0.	57423.	0.	210461.	0.	0.	0.	0.	0.
60	0.	60814.	0.	172825.	0.	0.	0.	666.	0.
61	0.	63699.	0.	182108.	0.	0.	0.	0.	0.
62	0.	67910.	0.	231193.	0.	0.	0.	400.	2015.
63	0.	64503.	0.	257117.	0.	0.	0.	550.	0.
64	0.	68104.	0.	341283.	0.	0.	0.	0.	0.
65	0.	67383.	0.	251448.	0.	0.	0.	0.	0.
66	0.	72010.	0.	329765.	0.	0.	0.	0.	300.
67	0.	73936.	0.	432457.	0.	0.	0.	915.	552.
68	0.	71438.	0.	385830.	0.	0.	0.	0.	0.
69	0.	59825.	0.	440010.	0.	0.	0.	0.	0.
70	0.	0.	0.	424469.	0.	0.	0.	0.	0.
71	0.	0.	0.	525454.	0.	0.	0.	0.	200.
72	0.	0.	0.	595422.	0.	0.	0.	680.	1818.
73	0.	0.	0.	772362.	0.	0.	0.	1400.	3632.
74	0.	0.	0.	652607.	0.	0.	0.	0.	0.
75	0.	0.	0.	570840.	0.	0.	0.	0.	0.

Table B. 11: Individual River Tonnages by Commodity Group and Direction - Kentucky River - Down

	Coal and Coke	Petroleum Fuels	Crude Petroleum	Aggregates	Grains	Chemical and Chemical Fertilizers	Ores and Minerals	Iron Ore and Iron and Steel	All Other
40	0.	0.	0.	1250.	0.	0.	0.	0.	0.
41	0.	0.	0.	1750.	0.	0.	0.	0.	0.
42	7025.	950.	0.	18340.	0.	0.	0.	0.	0.
43	5160.	500.	0.	13295.	0.	0.	0.	0.	0.
44	0.	0.	0.	1000.	0.	0.	0.	0.	0.
45	0.	20614.	0.	200.	0.	0.	0.	0.	0.
46	0.	0.	0.	4350.	0.	0.	0.	0.	0.
47	0.	0.	0.	8220.	0.	0.	2175.	0.	0.
48	2450.	0.	0.	10450.	0.	0.	2316.	0.	420.
49	0.	0.	0.	8100.	0.	0.	0.	0.	0.
50	0.	0.	0.	8950.	0.	0.	0.	0.	0.
51	0.	0.	0.	6045.	0.	0.	0.	0.	0.
52	5100.	0.	0.	9450.	0.	0.	0.	0.	0.
53	19288.	0.	0.	0.	0.	0.	0.	0.	0.
54	32550.	0.	0.	0.	0.	0.	0.	0.	0.
55	53583.	0.	0.	0.	0.	0.	0.	0.	239.
56	79962.	0.	0.	0.	0.	0.	0.	0.	0.
57	97532.	0.	0.	0.	0.	0.	0.	0.	0.
58	77235.	0.	0.	6761.	0.	0.	0.	1773.	0.
59	126707.	0.	0.	0.	0.	0.	0.	3586.	0.
60	160214.	4314.	0.	0.	0.	0.	0.	800.	0.
61	181688.	0.	0.	0.	0.	0.	0.	0.	0.
62	130688.	0.	0.	0.	0.	0.	0.	0.	0.
63	95289.	0	0.	0.	0.	0.	0.	0.	0.
64	52455.	0.	0.	0.	0.	0.	0.	0.	0.
65	0.	0.	0.	0.	0.	0.	0.	0.	0.
66	0.	0.	0.	0.	0.	0.	0.	0.	1200.
67	0.	0.	0.	408240.	0.	0.	0.	2303.	588.
68	0.	0.	0.	582166.	0.	0.	0.	580.	0.
69	0.	0.	0.	0.	0.	0.	0.	0.	200.
70	0.	0.	0.	1480.	0.	0.	0.	0.	0.
71	0.	0.	0.	0.	0.	0.	0.	0.	300.
72	0.	0.	0.	1070.	0.	0.	0.	0.	0.
73	0.	0.	0.	0.	0.	0.	0.	0.	500.
74	0.	0.	0.	0.	0.	0.	0.	0.	0.
75	9641.	0.	0.	0.	0.	0.	0.	0.	0.

Table B. 12: Individual River Tonnages by Commodity Group and Direction - Green River - Up

	Coal and Coke	Petroleum Fuels	Crude Petroleum	Aggregates	Grains	Chemical and Chemical Fertilizers	Ores and Minerals	Iron Ore and Iron and Steel	All Other
40	0.	12662.	0.	320.	0.	0.	0.	0.	321.
41	0.	18442.	0.	760.	0.	0.	0.	0.	100.
42	1000.	17905.	2023.	0.	0.	0.	0.	0.	0.
43	2870.	16946.	0.	1400.	0.	0.	0.	16956.	0.
44	10034.	13260.	0.	9600.	0.	0.	0.	0.	0.
45	12360.	16862.	424.	15125.	0.	0.	0.	0.	0.
46	0.	21539.	0.	1200.	0.	0.	0.	0.	0.
47	0.	24652.	0.	0.	0.	0.	0.	0.	0.
48	0.	36730.	0.	0.	0.	0.	0.	1366.	0.
49	0.	43885.	0.	0.	0.	0.	0.	1155.	165.
50	0.	44486.	0.	0.	0.	0.	0.	0.	0.
51	0.	53141.	0.	0.	0.	0.	0.	0.	0.
52	0.	60111.	0.	0.	0.	0.	0.	0.	0.
53	0.	50925.	0.	0.	0.	0.	0.	0.	0.
54	0.	46969.	0.	15150.	0.	0.	0.	5764.	0.
55	0.	49916.	0.	103700.	0.	0.	0.	1110.	19350.
56	0.	41946.	0.	0.	0.	0.	0.	0.	0.
57	0.	20607.	0.	0.	0.	0.	0.	1732.	0.
58	0.	17868.	0.	0.	0.	0.	0.	473.	0.
59	0.	20518.	0.	2300.	0.	0.	0.	0.	523.
60	0.	8642.	0.	0.	0.	0.	0.	0.	1156.
61	0.	8961.	0.	2000.	0.	0.	0.	752.	0.
62	1400.	8205.	0.	1400.	0.	0.	0.	774.	0.
63	2364.	10520.	0.	0.	0.	0.	0.	2764.	969.
64	0.	7544.	0.	0.	0.	0.	0.	300.	0.
65	600.	2289.	0.	4348.	0.	0.	0.	0.	1800.
66	0.	0.	0.	9250.	0.	0.	0.	600.	0.
67	0.	0.	0.	0.	0.	0.	0.	0.	0.
68	1428.	0.	0.	378049.	0.	0.	0.	509.	0.
69	0.	0.	0.	25300.	0.	0.	0.	252.	9717.
70	529827.	0.	0.	235212.	0.	0.	0.	0.	579.
71	24619.	0.	0.	1150.	47601.	0.	1415.	351.	3756.
72	573858.	0.	0.	900.	0.	0.	0.	649.	3236.
73	2187.	0.	0.	0.	0.	0.	0.	0.	0.
74	5121.	0.	0.	0.	0.	181440.	2890.	0.	0.
75	1487.	0.	0.	0.	0.	0.	1582.	0.	0.

Table B.13: Individual River Tonnages by Commodity Group and Direction - Green River - Down

	Coal and Coke	Petroleum Fuels	Crude Petroleum	Aggregates	Grains	Chemical and Chemical Fertilizers	Ores and Minerals	Iron Ore and Iron and Steel	All Other
40	3200.	4239.	0.	0.	0.	0.	0.	0.	120979.
41	0.	0.	9806.	0.	0.	0.	0.	0.	119000.
42	0.	5462.	0.	0.	0.	0.	0.	0.	78000.
43	0.	2576.	0.	1000.	0.	0.	67000.	2576.	200.
44	0.	3545.	1784.	0.	0.	0.	100400.	0.	155.
45	0.	1476.	0.	1600.	0.	0.	145000.	0.	325.
46	0.	0.	0.	0.	0.	0.	10700.	0.	0.
47	0.	0.	0.	0.	0.	0.	0.	0.	340.
48	0.	0.	8534.	0.	0.	0.	0.	0.	127.
49	0.	0.	1234.	0.	0.	0.	0.	0.	0.
50	0.	0.	0.	0.	0.	0.	0.	0.	0.
51	0.	0.	17184.	0.	0.	0.	0.	0.	0.
52	0.	33322.	0.	0.	0.	0.	0.	0.	0.
53	0.	0.	12183.	0.	0.	0.	0.	0.	0.
54	129737.	0.	9005.	0.	0.	0.	0.	0.	0.
55	195360.	0.	10942.	26300.	0.	0.	0.	0.	0.
56	1194374.	0.	11662.	0.	0.	0.	0.	651.	0.
57	2666500.	0.	4511.	0.	0.	0.	0.	0.	0.
58	4772106.	0.	4513.	0.	0.	0.	0.	0.	0.
59	5141431.	0.	0.	0.	0.	0.	0.	0.	5346.
60	5436567.	0.	0.	0.	0.	0.	0.	0.	0.
61	7578829.	0.	0.	0.	0.	0.	0.	0.	0.
62	8482522.	0.	0.	0.	0.	0.	0.	0.	0.
63	7746067.	0.	0.	1400.	0.	0.	0.	0.	200.
64	10353876.	0.	0.	0.	0.	0.	0.	0.	1800.
65	11294937.	0.	0.	1805.	1400.	0.	0.	0.	2548.
66	11655995.	0.	0.	10450.	0.	0.	0.	0.	860.
67	13503224.	0.	0.	0.	0.	0.	0.	793.	4396.
68	15809522.	0.	0.	0.	0.	0.	0.	0.	1975.
69	15324518.	0.	0.	7738.	0.	0.	0.	2695.	545.
70	16135966.	0.	0.	0.	1320.	0.	1402.	0.	0.
71	14470205.	0.	0.	4210.	57100.	0.	0.	510.	0.
72	15616647.	0.	0.	2941.	47498.	0.	0.	0.	0.
73	15458181.	0.	0.	0.	56969.	0.	0.	0.	0.
74	15372584.	0.	0.	0.	77586.	0.	0.	100.	0.
75	15797944.	0.	0.	1171.	91461.	0.	0.	0.	0.

Table B. 14: Individual River Tonnages by Commodity Group and Direction - Cumberland River - Up

	Coal and Coke	Petroleum Fuels	Crude Petroleum	Aggregates	Grains	Chemical and Chemical Fertilizers	Ores and Minerals	Iron Ore and Iron and Steel	All Other
1940	440.	354417.	0.	38608.	36881.	0.	6027.	3922.	16356.
1941	335.	437986.	6322.	2200.	17384.	0.	6610.	0.	22449.
1942	200.	368585.	1041.	500401.	22292.	0.	13262.	2879.	5969.
1943	0.	284891.	1069.	314651.	18655.	0.	34770.	1106.	12635.
1944	0.	381202.	0.	102857.	76493.	0.	19687.	0.	5343.
1945	0.	398840.	0.	40045.	25851.	0.	10910.	0.	0.
1946	0.	405586.	0.	4987.	1540.	0.	12544.	1443.	3453.
1947	0.	551979.	0.	225091.	0.	0.	12544.	4693.	3274.
1948	0.	618276.	0.	341857.	0.	0.	16594.	15186.	69402.
1949	0.	727585.	1049.	303062.	0.	0.	13161.	35757.	22467.
1950	0.	856140.	0.	258266.	0.	3754.	15239.	26925.	32562.
1951	0.	943809.	0.	544609.	3249.	6767.	17340.	22543.	18299.
1952	0.	1013249.	0.	840696.	2856.	11951.	14103.	24455.	16322.
1953	0.	1002478.	0.	708605.	0.	13394.	17385.	51984.	30710.
1954	1519.	1059170.	0.	630702.	0.	0.	31448.	64574.	47561.
1955	0.	1107594.	0.	660781.	0.	1574.	39501.	52514.	67495.
1956	0.	1163797.	0.	809210.	0.	2064.	34927.	71104.	78815.
1957	0.	1246047.	0.	407698.	0.	6722.	31265.	78380.	137258.
1958	0.	1285298.	0.	796257.	0.	10077.	31819.	67643.	228182.
1959	0.	1453179.	0.	967547.	0.	10388.	32928.	60682.	223765.
1960	0.	1439035.	0.	1017562.	0.	25716.	34294.	60471.	172026.
1961	2416.	1509373.	0.	934314.	0.	49971.	18595.	64834.	179609.
1962	0.	1631004.	0.	1040662.	0.	53734.	12534.	67935.	233729.
1963	0.	1751154.	0.	1166657.	0.	65004.	15570.	78207.	229734.
1964	0.	1220422.	0.	1228360.	0.	80492.	15280.	76156.	211208.
1965	0.	901007.	0.	1358571.	0.	105936.	19016.	73525.	257960.
1966	0.	1176013.	0.	1270645.	3283.	137380.	15258.	68628.	314981.
1967	646.	1199959.	0.	1334963.	4188.	204745.	22025.	114433.	222552.
1968	294966.	1294884.	0.	1330960.	35372.	250479.	27423.	116607.	406126.
1969	22009.	1348019.	0.	1267847.	22678.	221462.	7396.	83912.	367639.
1970	348508.	1490109.	0.	1146650.	30799.	278296.	23836.	138560.	411445.
1971	133241.	1647686.	0.	0.	0.	277148.	1328706.	174320.	463495.
1972	2293870.	1279175.	0.	0.	0.	311666.	1638683.	228554.	446263.
1973	4365887.	813129.	0.	0.	8386.	295838.	1908750.	222190.	509865.
1974	4463401.	779359.	0.	0.	0.	271266.	1779001.	190960.	438911.
1975	6122716.	1023833.	2842.	0.	1327.	116824.	1418898.	163824.	387627.

Table B. 15: Individual River Tonnages by Commodity Group and Direction - Cumberland River - Down

	Coal and Coke	Petroleum Fuels	Crude Petroleum	Aggregates	Grains	Chemical and Chemical Fertilizers	Ores and Minerals	Iron Ore and Iron and Steel	All Other
1940	0.	0.	0.	331581.	0.	0.	20604.	10132.	31170.
1941	0.	0.	0.	515330.	0.	0.	0.	10348.	39776.
1942	0.	0.	0.	237687.	0.	0.	30785.	4128.	39338.
1943	0.	0.	0.	0.	0.	0.	0.	0.	44282.
1944	0.	0.	0.	118628.	0.	0.	28207.	0.	42224.
1945	0.	0.	0.	285727.	0.	0.	20636.	0.	31824.
1946	0.	0.	0.	558295.	0.	0.	0.	0.	38526.
1947	0.	0.	0.	373675.	0.	0.	10313.	0.	24038.
1948	0.	209.	0.	243395.	0.	0.	17528.	0.	29309.
1949	0.	0.	0.	341289.	0.	0.	11674.	4967.	17532.
1950	0.	0.	0.	406846.	0.	0.	18908.	16077.	17810.
1951	0.	3772.	0.	189386.	0.	0.	12828.	6282.	11157.
1952	0.	0.	0.	16452.	0.	0.	17092.	28234.	182738.
1953	400.	8791.	0.	351192.	0.	0.	20610.	57630.	232086.
1954	1000.	2950.	0.	342161.	0.	0.	9026.	22902.	19675.
1955	7100.	0.	0.	546774.	0.	0.	7260.	50963.	336033.
1956	700.	1676.	0.	128905.	0.	0.	3389.	51067.	692812.
1957	0.	0.	0.	387463.	0.	0.	5479.	51904.	314955.
1958	0.	2297.	0.	2150.	0.	0.	3244.	39380.	392318.
1959	0.	2712.	0.	17379.	0.	0.	9566.	47645.	77381.
1960	0.	4211.	0.	12781.	0.	0.	2049.	30471.	16150.
1961	625.	0.	0.	15666.	4203.	3604.	638.	36022.	18158.
1962	0.	0.	0.	46985.	0.	8290.	0.	19397.	19155.
1963	0.	2189.	0.	14899.	0.	6182.	0.	24742.	21120.
1964	0.	0.	0.	80474.	0.	10262.	0.	28994.	24987.
1965	37400.	12470.	0.	124234.	0.	23249.	0.	35241.	77059.
1966	111880.	3075.	0.	75858.	0.	23722.	0.	29195.	174105.
1967	166650.	0.	0.	199279.	0.	37108.	0.	43735.	172683.
1968	131013.	2675.	0.	134882.	0.	50233.	0.	16892.	994041.
1969	169476.	4079.	0.	95296.	0.	42873.	0.	23253.	953649.
1970	170702.	18142.	0.	460049.	0.	44200.	1401.	34987.	971554.
1971	4449.	43122.	0.	0.	0.	45945.	787827.	20008.	866408.
1972	30828.	2946.	0.	0.	6057.	41163.	1012522.	45327.	914217.
1973	281655.	4539.	0.	1000.	15535.	53223.	737770.	54759.	1483594.
1974	43272.	3487.	0.	16625.	16888.	28516.	1235657.	67190.	1704492.
1975	71844.	28005.	0.	0.	3810.	23095.	933210.	31673.	1530617.

Table B. 16: Individual River Tonnages by Commodity Group and Direction - Tennessee River - Up

	Coal and Coke	Petroleum Fuels	Crude Petroleum	Aggregates	Grains	Chemical and Chemical Fertilizers	Ores and Minerals	Iron Ore and Iron and Steel	All Other
1940	9919.	102882.	0.	1251479.	43140.	0.	0.	1403.	7966.
1941	6794.	115353.	0.	1600172.	85237.	1120.	0.	2114.	11979.
1942	27751.	200075.	0.	1292614.	91361.	0.	0.	9090.	54874.
1943	138330.	142228.	0.	424348.	123365.	0.	0.	19864.	87799.
1944	100500.	121891.	0.	300603.	113642.	0.	0.	2332.	6647.
1945	338724.	210151.	0.	458452.	122861.	0.	0.	2656.	21725.
1946	157988.	346010.	0.	1014185.	78301.	0.	0.	892.	29215.
1947	248166.	322069.	0.	1230870.	79567.	1193.	0.	2863.	47963.
1948	304613.	487187.	0.	938480.	62054.	0.	0.	2119.	43878.
1949	249061.	601921.	0.	821001.	92929.	0.	5488.	40424.	46735.
1950	156593.	742586.	0.	733536.	148545.	450.	14052.	100364.	64638.
1951	354900.	706881.	0.	1011745.	138787.	509.	22707.	28794.	83434.
1952	1875606.	794275.	0.	1038231.	201799.	0.	46047.	37739.	83307.
1953	2544957.	727472.	0.	1397976.	330835.	17997.	89702.	138296.	103595.
1954	3147338.	747793.	0.	1169324.	383055.	44292.	97387.	183993.	103040.
1955	4176903.	822076.	0.	1011299.	564684.	71989.	122179.	97506.	340654.
1956	5580954.	687833.	0.	1497290.	451694.	44385.	147273.	122999.	767776.
1957	5831497.	596515.	0.	1532627.	847618.	54552.	106825.	183679.	949474.
1958	4270312.	636971.	0.	1271400.	1366895.	106198.	105483.	157256.	1185618.
1959	4357865.	595466.	0.	1621572.	1502244.	47213.	192429.	201360.	608012.
1960	4807059.	655754.	0.	1474044.	1715338.	77883.	178964.	198953.	825815.
1961	4025258.	498190.	0.	1430402.	1634948.	88061.	205896.	146193.	688257.
1962	3599510.	635514.	0.	1661314.	2323314.	112008.	357912.	155441.	771416.
1963	4542490.	677340.	0.	1802670.	1704577.	122575.	438431.	212324.	811887.
1964	4472053.	547859.	0.	1961298.	1392332.	136674.	511350.	212070.	802375.
1965	4609267.	886626.	0.	1997895.	1639358.	178950.	669487.	163499.	470615.
1966	5970886.	803626.	0.	2229788.	2107353.	255647.	756336.	167327.	740556.
1967	5582576.	1638779.	0.	2570499.	1953180.	493774.	862668.	258320.	670528.
1968	5771276.	2176008.	957.	2640512.	1665262.	805718.	1151968.	275304.	978707.
1969	6730034.	2198730.	1400.	2762618.	2440623.	1159689.	1120513.	310879.	1017521.
1970	6606783.	2235794.	0.	2606111.	2744960.	1201685.	1004180.	362728.	1358676.
1971	6748464.	2702902.	0.	3432524.	2710466.	1348558.	949838.	444646.	1449097.
1972	7140730.	2510377.	0.	4086560.	1780874.	1675438.	790170.	591966.	1356992.
1973	7711550.	1778367.	0.	4237880.	1768187.	1832450.	842723.	604330.	1330603.
1974	5820528.	1504917.	0.	3853355.	1660426.	1989110.	998921.	640818.	1251745.
1975	8322397.	2157385.	833.	3164960.	1299778.	1654073.	739894.	437764.	1221572.

APPENDIX C: Key Lock and Dam Data Set

Note: A zero entry indicates that data was not available for that year, or the lock had not yet opened. It does not necessarily mean that tonnage of that particular commodity group did not move in the year indicated.

Table C. 1: Historic Key Lock and Dam Traffic by Major Commodity Group

Montgomery Lock and Dam - Ohio River

YEAR	Coal & Coke	Petroleum Fuels	Aggregates	Iron Ore and Iron & Steel
40	0.	0.	0.	0.
41	0.	0.	0.	0.
42	0.	0.	0.	0.
43	0.	0.	0.	0.
44	0.	0.	0.	0.
45	3100000.	975000.	0.	450000.
46	4450000.	900000.	750000.	325000.
47	0.	0.	0.	0.
48	0.	0.	0.	0.
49	5000000.	1200000.	1500000.	975000.
50	6600000.	1725000.	2000000.	1575000.
51	0.	0.	0.	0.
52	5600000.	2125000.	2500000.	1500000.
53	6700000.	2200000.	2300000.	2300000.
54	4300000.	2100000.	2300000.	2475000.
55	6900000.	2600000.	2550000.	3075000.
56	7522765.	2812909.	2390215.	3036608.
57	7876238.	2955418.	2150902.	3040147.
58	6590598.	2591567.	2275849.	2038878.
59	6709503.	2771285.	0.	2378527.
60	6712507.	2641666.	1481156.	2133880.
61	6922937.	2390792.	1436546.	1854814.
62	7336369.	2315642.	1786661.	1811033.
63	7645736.	2484467.	1826425.	1832736.
64	8335171.	2885525.	2245551.	1781804.
65	8544529.	2964615.	2142150.	2060901.
66	10505592.	2530749.	2108135.	1693363.
67	9386326.	2798839.	2192948.	1725445.
68	8961664.	3042287.	2656826.	1977475.
69	7134522.	3034967.	2557181.	1948096.
70	6434406.	2941067.	2341022.	2452312.
71	6699260.	2138678.	2440397.	1939897.
72	6057957.	2591252.	2152417.	2379828.
73	6475052.	3106265.	2128846.	2262354.
74	6256669.	3703801.	2088184.	2403116.
75	6147037.	3428078.	1847149.	1902824.

Table C. 2: Historic Key Lock and Dam Traffic by Major Commodity Group

Lock & Dam #52 - Ohio River

YEAR	Coal & Coke	Petroleum Fuels	Chemicals & Chem. Fertilizers	All Others
40	0.	0.	0.	0.
41	0.	0.	0.	0.
42	0.	0.	0.	0.
43	0.	0.	0.	0.
44	0.	0.	0.	0.
45	25000.	4925000.	0.	0.
46	100000.	4100000.	0.	450000.
47	0.	0.	0.	0.
48	0.	0.	0.	0.
49	125000.	5425000.	0.	8350000.
50	100000.	5725000.	0.	1025000.
51	0.	0.	0.	0.
52	850000.	5850000.	875000.	850000.
53	1400000.	5325000.	900000.	1150000.
54	2550000.	6200000.	675000.	800000.
55	2850000.	7200000.	950000.	1400000.
56	2919211.	7136295.	1156628.	1421293.
57	4178300.	6506344.	1266423.	1588557.
58	4544556.	6487032.	1285147.	2095928.
59	4525760.	7401673.	1401474.	2159037.
60	4766522.	8008836.	1675579.	2521116.
61	5422566.	8794236.	1826055.	2248710.
62	6404391.	9032790.	1871688.	2635777.
63	6541036.	9044634.	2070315.	3513062.
64	6754159.	8773907.	2401593.	3980193.
65	6630633.	8306214.	2744164.	5636854.
66	7418950.	8359314.	3273891.	6464363.
67	9250062.	8287784.	3833213.	6067139.
68	10196036.	9976453.	3999660.	6715929.
69	12094404.	9702261.	5240200.	6144912.
70	13291900.	10510642.	5942115.	7252177.
71	12156369.	8765814.	6596005.	8551671.
72	14208433.	8966357.	7264432.	6395895.
73	13546541.	9611558.	6981517.	6557968.
74	15553733.	10396086.	7742786.	7975263.
75	15199390.	9845990.	6454393.	7605787.

Table C. 3: Historic Key Lock and Dam Traffic
by Major Commodity Group

Gallipolis Lock and Dam - Ohio River

YEAR	Coal & Coke	Petroleum Fuels	Chemicals & Chem. Fertilizers	Iron Ore and Iron & Steel
40	0.	0.	0.	0.
41	0.	0.	0.	0.
42	0.	0.	0.	0.
43	0.	0.	0.	0.
44	0.	0.	0.	0.
45	0.	0.	0.	0.
46	2500000.	1250000.	0.	850000.
47	0.	0.	0.	0.
48	3400000.	1300000.	0.	1300000.
49	3250000.	1350000.	0.	1400000.
50	5450000.	2100000.	0.	2050000.
51	5000000.	2700000.	0.	1800000.
52	4750000.	2850000.	750000.	2050000.
53	4850000.	2900000.	900000.	3050000.
54	3900000.	2550000.	700000.	3100000.
55	5900000.	3300000.	950000.	3900000.
56	6357671.	3545220.	1098445.	4093176.
57	7302095.	3721109.	1281595.	3876189.
58	6768213.	3567657.	1220120.	2708252.
59	8084396.	4100920.	1321534.	3073069.
60	8078283.	4084071.	1456982.	2813568.
61	7811552.	4148646.	1644093.	2391012.
62	7746396.	3999381.	1692636.	2298603.
63	8429179.	4213272.	1782050.	2279592.
64	9291394.	4925763.	2042756.	2258587.
65	9740299.	4940512.	2615195.	2707447.
66	10638845.	4700227.	2737777.	2353788.
67	10759152.	5027060.	2855371.	2380894.
68	11046050.	5231213.	2960618.	2565438.
69	11073583.	5250689.	3858374.	2562809.
70	11800005.	5498857.	4069600.	3364660.
71	13783087.	4548801.	4248933.	2595086.
72	12528169.	5025788.	4005967.	3263720.
73	10832310.	5831272.	3187543.	3138042.
74	13805551.	7043088.	3371257.	3351362.
75	17257200.	6265003.	2554111.	2637483.

Table C. 4: Historic Key Lock and Dam Traffic by Major Commodity Group

Lock and Dam #2 - Allegheny River

YEAR	Coal & Coke	Aggregates	Iron Ore and Iron & Steel	All Other
40	0.	0.	0.	0.
41	0.	0.	0.	0.
42	0.	0.	0.	0.
43	0.	0.	0.	0.
44	0.	0.	0.	0.
45	1088000.	211000.	42000.	26000.
46	996000.	384000.	0.	32320.
47	1055000.	356000.	0.	21000.
48	1620000.	610000.	15000.	20000.
49	1850000.	331000.	22000.	21000.
50	1620000.	459000.	58000.	24000.
51	1750000.	556000.	42000.	24000.
52	1420000.	580000.	44000.	48000.
53	1612000.	512000.	188000.	76000.
54	2233000.	727000.	243000.	133000.
55	1785000.	410000.	225000.	145000.
56	2151000.	425000.	236000.	60000.
57	2324040.	321000.	157000.	83000.
58	1898000.	576000.	182000.	68000.
59	1530000.	360000.	218000.	103000.
60	1674000.	316000.	252000.	80000.
61	1952000.	244000.	246000.	56000.
62	1976000.	228000.	146000.	92000.
63	1869000.	420000.	198000.	143000.
64	1894000.	337000.	219000.	156000.
65	1875000.	329000.	246000.	204000.
66	1857000.	320000.	273000.	252000.
67	1880000.	256000.	256000.	300000.
68	1425849.	421684.	300999.	281127.
69	2127675.	342868.	317704.	347203.
70	2349300.	419166.	166209.	279376.
71	2275886.	469832.	136868.	435597.
72	2178842.	640455.	179911.	440524.
73	1853916.	708008.	17819.	513597.
74	2219862.	632210.	196214.	481534.
75	2094074.	620417.	220051.	439635.

Table C. 5: Historic Key Lock and Dam Traffic by Major Commodity Group

Lock and Dam #7 - Monongahela River

YEAR	Coal & Coke	Petroleum Fuels	Aggregates
40	0.	0.	0.
41	0.	0.	0.
42	0.	0.	0.
43	0.	0.	0.
44	0.	0.	0.
45	1780000.	60000.	70000.
46	1990000.	90000.	70000.
47	2740000.	110000.	180000.
48	3200000.	120000.	170000.
49	2250000.	190000.	130000.
50	2450000.	200000.	100000.
51	2600000.	200000.	90000.
52	2440000.	160000.	140000.
53	1979000.	200000.	40000.
54	1555000.	210000.	127000.
55	2515000.	110000.	100000.
56	4770000.	180000.	120000.
57	7379000.	160000.	100000.
58	5949000.	170000.	170000.
59	5870000.	180000.	160000.
60	622000.	210000.	150000.
61	5543000.	230000.	60000.
62	6427000.	245000.	95000.
63	7311000.	260000.	130000.
64	8155000.	275000.	165000.
65	9080000.	290000.	200000.
66	7619000.	290000.	604000.
67	7970000.	280000.	580000.
68	7045561.	307540.	560407.
69	7444207.	325445.	557241.
70	9281560.	336826.	420586.
71	7352538.	294229.	424980.
72	8700179.	244093.	477561.
73	8012240.	303765.	521965.
74	7891803.	312422.	450610.
75	6891492.	323093.	523875.

Table C.6: Historic Key Lock and Dam Traffic by Major Commodity Group

Winfield Lock and Dam - Kanawha River

YEAR	Coal & Coke	Aggregates	Chemicals & Chem. Fertilizers
40	0.	0.	0.
41	0.	0.	0.
42	0.	0.	0.
43	0.	0.	0.
44	0.	0.	0.
45	0.	0.	0.
46	0.	0.	0.
47	0.	0.	0.
48	0.	0.	0.
49	0.	0.	0.
50	0.	0.	0.
51	0.	0.	0.
52	0.	0.	0.
53	0.	0.	0.
54	0.	0.	0.
55	0.	0.	0.
56	0.	0.	0.
57	0.	0.	0.
58	0.	0.	0.
59	0.	0.	0.
60	0.	0.	0.
61	0.	0.	0.
62	0.	0.	0.
63	0.	0.	0.
64	0.	0.	0.
65	0.	0.	0.
66	0.	0.	0.
67	4883966.	662889.	3229092.
68	5005262.	848606.	3714043.
69	5052919.	1118841.	3815387.
70	5044695.	1147627.	3841653.
71	4666989.	1637451.	4067659.
72	5109392.	1572196.	3910007.
73	5376597.	1408803.	3490118.
74	4278319.	1595552.	3389352.
75	3720808.	1625490.	2588335.

Table C.7: Historic Key Lock and Dam Traffic
by Major Commodity Group

Lock and Dam #1 - Kentucky River

YEAR	Aggregates
40	0.
41	0.
42	0.
43	0.
44	0.
45	0.
46	0.
47	0.
48	0.
49	0.
50	0.
51	0.
52	0.
53	0.
54	0.
55	53030.
56	66562.
57	0.
58	0.
59	210461.
60	172825.
61	182108.
62	231193.
63	257117.
64	341283.
65	251448.
66	329765.
67	432457.
68	385830.
69	440010.
70	425949.
71	525454.
72	598990.
73	772362.
74	652607.
75	570840.

Table C. 8: Historic Key Lock and Dam Traffic by Major Commodity Group

Lock and Dam #1 - Green River

YEAR	Coal & Coke
40	0.
41	0.
42	0.
43	0.
44	0.
45	0.
46	0.
47	0.
48	0.
49	0.
50	0.
51	0.
52	0.
53	0.
54	0.
55	0.
56	1014924.
57	0.
58	0.
59	4964059.
60	5238071.
61	7322158.
62	8220649.
63	7494652.
64	10104221.
65	11091633.
66	11430184.
67	13279568.
68	15561601.
69	15039759.
70	16137442.
71	14001191.
72	15613571.
73	15082758.
74	15157198.
75	15454541.

Table C. 9: Historic Key Lock and Dam Traffic by Major Commodity Group

Cheatham Lock and Dam - Cumberland River

YEAR	Petroleum Fuels	Aggregates	All Other
40	0.	0.	0.
41	0.	0.	0.
42	0.	0.	0.
43	0.	0.	0.
44	0.	0.	0.
45	0.	0.	0.
46	0.	0.	0.
47	0.	0.	0.
48	0.	0.	0.
49	0.	0.	0.
50	0.	0.	0.
51	0.	0.	0.
52	0.	0.	0.
53	0.	0.	0.
54	0.	0.	0.
55	0.	0.	0.
56	0.	0.	0.
57	0.	0.	0.
58	1441890.	760954.	80189.
59	1543038.	834111.	88281.
60	1515549.	818423.	74204.
61	0.	0.	0.
62	0.	0.	0.
63	1872875.	981016.	52238.
64	1357099.	1153638.	28031.
65	0.	0.	0.
66	0.	0.	0.
67	1341361.	1225920.	69313.
68	0.	0.	0.
69	1483214.	1194694.	241148.
70	1630946.	1039550.	275664.
71	1690808.	1170902.	517476.
72	1282121.	1472040.	508258.
73	792570.	1636643.	574157.
74	765453.	1379334.	530050.
75	1005483.	1222359.	499993.

Table C. 10: Historic Key Lock and Dam Traffic
by Major Commodity Group

Kentucky Lock and Dam - Tennessee River

YEAR	Coal & Coke	Petroleum Fuels	Aggregates	All Other
40	0.	0.	0.	0.
41	0.	0.	0.	0.
42	0.	0.	0.	0.
43	0.	0.	0.	0.
44	0.	0.	0.	0.
45	0.	0.	0.	0.
46	0.	0.	0.	0.
47	0.	0.	0.	0.
48	0.	0.	0.	0.
49	0.	0.	0.	0.
50	0.	0.	0.	0.
51	0.	0.	0.	0.
52	0.	0.	0.	0.
53	0.	0.	0.	0.
54	0.	0.	0.	0.
55	0.	0.	0.	0.
56	0.	0.	0.	0.
57	0.	0.	0.	0.
58	1386290.	695455.	37350.	927171.
59	1537090.	656807.	517181.	548882.
60	1466469.	714509.	15800.	1383042.
61	996400.	492000.	624169.	181000.
62	455816.	692131.	39185.	1211621.
63	432271.	795204.	6174.	1685662.
64	1907066.	651869.	14991.	2028894.
65	3375126.	671772.	70215.	707753.
66	3755101.	722057.	477450.	762118.
67	3886683.	1613031.	1339065.	2803424.
68	4181109.	2158040.	2188186.	1922042.
69	5202346.	2254833.	1832920.	1656181.
70	5271614.	2396470.	1677866.	2153718.
71	6550397.	2246294.	1400514.	3107315.
72	7436084.	2034775.	1508311.	2978484.
73	7768649.	1379491.	2921500.	3212377.
74	6340953.	1481131.	1936058.	5024120.
75	9926105.	2188486.	1462516.	4839570.

APPENDIX D: Initial Inspection of O-D Movements, 1969-1976, By Commodity Group

Table D. 1

Year / Comm. Group	1969	1970	1971	1972	1973	1974	1975	1976
Totals	160,625,000	167,222,000	166,966,000	174,596,000	168,811,000	170,505,000	171,447,000	178,100,000
Coal & Coke 1	54.14%	53.64%	50.66%	53.93%	54.24%	54.46%	58.12%	58.10%
	86,962,000	89,693,000	84,711,000	94,168,000	91,568,000	92,850,000	99,646,000	103,480,000
Petroleum Fuels 2	9.17	9.31	9.83	10.03	10.62	11.14	11.03	10.71
	14,722,000	15,573,000	16,432,000	17,514,000	17,920,000	18,997,000	18,907,000	19,076,000
Crude Petroleum 3	4.10	4.24	4.76	4.47	2.50	.38	.51	.50
	6,593,000	7,090,000	7,957,000	7,811,000	4,220,000	644,000	867,000	885,000
Aggregates 4	14.32	12.91	14.40	12.95	14.03	13.55	11.87	11.91
	23,001,000	21,581,000	24,074,000	22,617,000	23,683,000	23,107,000	20,358,000	21,205,000
Grains 5	2.06	2.02	2.41	1.80	1.78	1.97	2.39	3.02
	3,304,000	3,375,000	4,028,000	3,148,000	3,013,000	3,355,000	4,097,000	5,380,000
Chemicals & Chem. Fert. 6	6.17	7.11	6.89	6.53	6.27	6.81	5.46	5.34
	9,915,000	11,885,000	11,521,000	11,406,000	10,584,000	11,610,000	9,362,000	9,507,000
Ores & Minerals 7	2.16	2.35	2.66	2.07	1.80	2.19	2.01	1.88
	3,474,000	3,925,000	4,443,000	3,614,000	3,046,000	3,728,000	3,444,000	3,345,000
Iron Ore & Iron & Steel 8	2.59	3.11	2.68	3.09	3.20	3.01	2.43	2.42
	4,167,000	5,198,000	4,478,000	5,397,000	5,403,000	5,128,000	4,164,000	4,303,000
All Other 9	5.28	5.32	5.57	5.11	5.55	6.50	6.18	6.13
	8,487,000	8,902,000	9,322,000	8,921,000	9,374,000	11,086,000	10,602,000	10,919,000

Table D. 2

P/A

COMMODITY GROUP 1

Origin BEA	'69 99.97	'70 99.87	'71 99.72	'72 99.12	'73 98.55	'74 97.80	'75 97.12	'76 97.33
66	30,960,310 35.60	30,854,945 34.40	25,131,806 29.67	28,579,605 30.35	29,310,959 32.01	31,863,731 34.42	32,634,377 32.75	32,222,877 31.14
55	24,374,782 28.03	25,655,552 28.60	21,918,438 25.87	26,376,685 28.01	27,845,409 30.41	28,847,045 31.17	30,246,576 30.35	27,823,052 26.89
52	17,344,977 19.95	17,126,000 19109	21,420,455 25.29	19,335,633 20.53	17,255,945 18.85	16,106,348 17.40	18,067,656 18.13	22,930,023 22.16
65	8,458,116 9.73	10,204,430 11.38	8,289,818 9.79	9,991,744 10.61	8,856,340 9.67	7,826,971 8.46	8,295,370 8.32	6,147,927 5.94
115	2,883,082 3.32	2,684,443 2.99	4,411,122 5.21	5,311,501 5.64	3,838,217 4.19	2,620,889 2.83	1,975,091 1.98	3,165,405 3.06
47	1,329,066 1.53	1,394,265 1.55	1,181,147 1.39	1,332,719 1.42	1,326,324 1.45	1,295,654 1.40	1,466,772 1.47	2,851,359 2.76
48	1,172,802 1.35	1,434,523 1.60	1,809,228 2.14	1,877,610 1.99	1,427,915 1.56	1,346,[illegible]02 1.46	1,456,851 1,46	1,420,281 1.37
64	190,800 .22	33,611 .04	37,824 .04	95,366 .10	105,573 .12	253,250 .27	848,889 .85	592,788 .57
49	159,600 .18	72,900 .08	-	-	-	-	-	-
54	56,230 .06	129,143 .14	263,590 .31	433,577 .46	201,256 .22	162,311 .18	1,572,872 1.58	2,043,157 1.97
62			5,929 .01	7,268 .01	62,906 .07	191,340 .21	232,528 .23	1,519,862 1.47

P/A

Table D. 3

COMMODITY GROUP 1

Destination BEA	'69 88.30	'70 87.15	'71 87.07	'72 86.38	'73 87.38	'74 86.42	'75 88.14	'76 88.14
66	39,766,110 45.73	41,634,831 46.42	34,870,279 41.16	36.942,567 39.23	36,373,386 40.12	36,375,661 39.30	34,926,028 35.05	39,292,824 37.97
52	9,408,472 10.82	8,828,212 9.84	10,765,780 12.71	9,270,882 9.84	8,898,615 9.72	10,490,328 11.33	12,648,942 12.69	14,270,263 13.79
62	7,079,707 8.14	8,145,968 9.08	9,081,825 10.72	11,051,162 11.73	10,657,350 11.64	11,914,429 12.87	12,938,090 12.98	13,723,565 13.26
54	5,993,309 6.89	5,309,667 5.92	5,793,376 6.84	8,041,876 8.54	4,856,099 5.30	4,687,653 5.06	7,332,567 7.36	7,253,286 7.01
47	3,830,401 4.40	3,749,067 4.18	3,493,006 4.12	3,698,180 3.93	3,945,137 4.31	2,598,594 2.81	3,544,550 3.56	3,556,146 3.44
49	3,615,415 4.16	3,269,718 3.65	3,025,486 3.57	5,285,948 5.61	7,251,566 7.92	6,562,840 7.09	9,634,261 9.67	7,114,687 6.88
65	3,097,905 3.56	2,904,466 3.24	2,358,784 2.78	2,979,502 3.16	2,724,489 2.98	1,704,670 1.84	2,903,463 2.91	1,714,892 1.66
115	2,377,875 2.73	2,030,256 2.26	1,602,226 1.89	1,849,417 1.96	1,751,243 1.91	2,543,994 2.75	2,506,574 2.52	2,960,006 2.86
48	1,266,260 1.46	1,124,853 1.25	1,310,124 1.55	1,580,519 1.68	1,261,620 1.38	1,189,771 1.29	1,016,707 1.02	856,554 .83
64	358,729 .41			655,403 .70	-	-	-	-
55		1,178,358 1.31	1,635,124 1.73		1,927,293 2.10	1,924,666 2.08	376,860 .38	450,982 .44

COMMODITY GROUP 2

Table D.4

P/A

Origin BEA	'69 54.18	'70 52.16	'71 53.67	'72 54.50	'73 51.22	'74 50.50	'75 52.39	'76 52.46
52	2,928,135 19.89	3,234,757 20.77	3,635,155 22.12	4,400,887 25.13	4,057,279 22.64	3,873,568 20.39	4,281,406 22.62	4,336,544 22.73
55	2,722,781 18.49	2,730,326 17.53	2,974,707 18.10	2,908,053 16.60	2,667,054 14.88	2,773,537 14.60	2,573,791 13.62	2,668,317 13.98
62	1,172,966 7.97	1,150,408 7.39	1,238,203 7.53	1,361,472 7.77	1,627,264 9.08	1,779,278 9.37	1,586,910 8.40	1,665,016 8.73
66	712,207 4.84	641,815 4.12	559,666 3.41	517,226 2.95	608,385 3.39	698,288 3.68	859,703 4.55	673,049 3.53
54	378,086 2.57	293,510 1.88	312,220 1.90	249,788 1.43	174,984 .98	326,289 1.72	404,112 2.14	389,567 2.04
115	40,914 .28	42,501 .27	31,190 .19	63,874 .36	20,492 .11	43,253 .23	78,922 .42	182,974 .96
64	7,383 .05	7,016 .05	17,140 .10	29,233 .17	13,381 .07	65,154 .34	36,838 .20	26,506 .14
47	5,932 .04	3,223 .02	7,277 .04	11,668 .07	12,897 .07	28,151 .15	55,555 .29	67,254 .35
49	4,679 .03	18,142 .12	43,122 .26	2,946 .02	-	2,141 .01	28,005 .15	-
48	2,635 .02	1,750 .10	-	-	-	-	-	-
	-	-	2,953 .02	-	-	-	-	-
	-	-	-	-	-	1,190 .01	-	-

Table D.5

P/A

COMMODITY GROUP 2

Destination BEA	'69 89.23	'70 89.22	'71 88.11	'72 90.78	'73 90.51	'74 87.58	'75 88.56	'76 88.40
54	2,713,449 18.43	2,905,599 18.66	3,011,814 18.33	3,380,593 19.30	3,650,428 20.37	3,619,17 19.05	3,467,663 18.36	3,513,730 18.42
66	2,455,673 16.68	2,697,854 17.32	2,693,389 16.39	3,089,102 17.64	3,660,070 20.42	4,519,392 23.79	4,120,090 21.81	3,739,360 19.60
62	1,723,567 11.70	1,649,153 10.59	1,764,068 10.73	2,020,704 11.54	2,170,366 12.11	1,902,788 10.02	1,966,285 10.41	1,869,422 9.80
52	1,584,741 10.76	1,742,223 11.19	1,847,943 11.25	2,233,444 12.75	2,207,485 12.32	2,485,959 13.09	2,378,181 12.59	2,435,905 12.77
49	1,340,658 9.10	1,462,392 9.39	1,647,686 10.03	1,279,175 7.30	792,570 4.42	763,312 4.02	1,157,757 6.13	1,479,040 7.75
55	1,046,919 7.11	1,088,996 6.99	1,102,163 6.71	1,220,189 6.97	1,188,860 6.63	1,201,948 6.33	1,276,878 6.76	1,352,305 7.09
115	1,112,703 7.56	1,095,311 7.03	1,171,407 7.13	1,242,654 7.09	1,188,781 6.63	796,806 4.19	806,515 4.27	980,108 5.14
64	572,448 3.89	615,508 3.95	661,542 4.03	745,474 4.26	676,541 3.77	683,370 3.60	655,678 3.47	594,392 3.12
64	326,692 2.22	335,983 2.16	294,229 1.79	244,093 1.39	303,765 1.69	311,232 1.64	-	-
47	261,835 1.78	302,859 1.94	291,855 1.72	444,888 2.54	834,527 2.15	351,968 1.85	471,129 2.49	443,764 2.33
48							429,522 2.27	455,059 2.38

COMMODITY GROUP 3

Table D. 6

Origin BEA	1969	1970	1971	1972	1973	1974	1975	1976 P/A
55	5863767 88.94	5929046 83.62	6614567 83.13	7012112 89.77	3522586 83.47	10065 1.56	72406 8.35	
62	508999 7.72	893321 12.60	1094851 13.76	556890 7.13	311600 7.38			
64	178079 2.70	197100 2.78	213925 2.69	213128 2.73	232302 5.50	189130 29.37	179738 19.69	
52	15029 .23	44991 .63		3067 .04	19301 .46	4189 .65	11027 1.27	
66	4781 .07					45510 7.07	122243 14.10	
47						654 .10		2749 .31
54							2591 .30	
TOTAL	6592947 99.66	7090464 99.63	7956895 99.58	7811198 99.67	4220182 96.81	643956 38.75	867130 43.71	886774 .31

COMMODITY GROUP 3

Table D. 7

P/A

Destination BEA	1969	1970	1971	1972	1973	1974	1975	1976
52	5242651 79.52	5774924 81.45	6512713 81.85	6366949 81.51	3091797 73.26	15783 2.45	22800 2.63	25023 2.83
54	1094854 16.61	1084840 15.30	1207841 15.18	1202053 15.39	742389 17.59			
66	193004 2.93	173102 2.44	213925 2.69	216195 2.77	252633 5.99	193547 30.06	204532 23.59	20749 2.35
55	17321 .26	2786 .04	22028 .28	16861 .22	116347 2.76	352904 54.81	417989 48.21	690277 78.15
47	1400 .02							
64	1222 .02	44991 .63			8840 .21	59576 9.25	127721 14.73	147233 16.67
62							16527 1.91	
115							2842 .33	
TOTAL	6592871 99.36	7090146 99.86	7956888 100.00	7811249 99.89	4220307 99.81	643868 96.57	867017 91.40	883208 100.00

COMMODITY GROUP 4

Table D.8

P/A

Origin BEA	'69 96.01	'70 95.22	'71 96.04	'72 88.60	'73 93.55	'74 95.46	'75 95.43	'76 96.10
54	5,695,060 24.76	4,180,366 19.37	4,643,497 19.29	4,247,540 18.78	4,911,925 20.74	4,396,922 19.03	4,816,639 23.66	5,429,281 25.60
66	4,531,378 24.05	4,688,932 21.72	5,102,301 21.20	3,018,635 13.35	4,444,996 18.77	4,465,972 19.32	3,780,998 18.57	4,601,440 21.70
115	2,803,794 12.19	3,460,758 16.03	3,619,904 15.04	3,666,744 16.21	3,871,830 16.35	4,633,641 20.05	3,480,490 17.09	3,779,448 17.82
62	1,994,902 8.67	1,770,602 8.20	2,423,187 10.07	2,411,272 10.66	1,680,273 7.1[illegible]	1,724,064 7.46	1,267,055 6.22	1,353,214 6.38
52	1,321,149 5.74	1,206,972 5.59	1,281,373 5.32	1,444,119 6.38	1,369,322 5.78	1,577,061 6.82	1,585,693 7.79	1,766,610 8.33
64	699,654 3.04	1,406,549 6.52	1,920,279 7.98	1,680,372 7.43	1,663,544 7.03	1,447,069 6.26	1,770,022 8.69	729,897 3.44
48	1,254,004 5.45	1,186,581 5.50	1,406,988 5.84	1,403,160 6.20	1,655,437 6.99	1,762,626 7.63	1,292,204 6.35	1,206,965 5.69
55	1,11,083 4.83	1,171,650 5.43	1,396,560 5.80	1,056,531 4.67	1,511,296 6.38	1,241,692 5.37	555,556 2.73	496,235 2.34
49	843,795 3.67	730,550 3.38	783,702 3.26	493,038 2.18	518,500 2.19	366,480 1.59	358,235 1.76	430,645 2.03
47	831,496 3.61	751,053 3.48	539,136 2.24	620,281 2.74	525,832 2.22			
65						447,100 1.93	523,875 2.57	586,334 2.77

COMMODITY GROUP 4

Table D. 9

P/A

Destination BEA	'69 96.55	'70 94.31	'71 93.62	'72 92.55	'73 94.17	'74 90.76	'75 96.01	'76 91.97
66	6,007,910 26.12	5,688,602 26.36	6,512,788 27.05	5,651,821 24.99	5,960,807 25.17	5,698,544 24.66	5,166,886 25.38	4,834,056 22.80
54	3,698,141 16.08	2,145,429 9.94	2,579,452 10.72	2,072,251 9.16	2,789,384 11.78	2,721,237 11.77	2,864,474 14.07	2,740,157 12.92
55	2,377,299 10.33	2,539,448 11.77	2,490,506 10.00	1,943,522 8.59	2,311,886 9.76	1,717,725 7.43	1,249,659 6.14	1,346,651 6.35
52	2,176,917 9.46	2,323,442 10.77	2,892,112 12.01	3,343,916 14.78	3,080,771 13.01	3,077,591 13.32	2,657,522 13.05	3,512,882 16.57
62	1,614,892 7.37	1,333,721 6.18	1,699,305 7.06	1,774,744 7.85	1,152,835 4.87	1,283,822 5.56	820,942 4.03	1,131,084 5.33
115	1,360,605 5.91	1,671,152 7.74	1,432,844 5.95	1,287,858 5.69	1,565,422 6.61	1,437,964 6.22	1,162,395 5.71	1,397,876 6.59
49	1,232,050 5.36	1,547,475 7.17	1,745,942 7.25	1,513,668 6.69	2,315,000 9.78	2,177,244 9.42	1,783,399 8.76	1,818,242 8.57
48	1,354,922 5.89	1,285,409 5.96	1,494,759 6.21	1,467,755 6.49	1,695,972 7.16	1,762,626 7.63	1,328,310 6.52	1,144,683 5.40
64	1,163,416 5.06	1,032,758 4.79	1,169,032 4.86	716,101 3.17	822,544 3.47	859,091 3.72	1,244,251 6.11	1,263,731 5.96
47	1,144,369 4.97	784,491 3.63	603,676 2.51	1,162,683 5.14	607,023 2.56	237,604 1.03	253,448 1.24	313,116 1.48

COMMODITY GROUP 5

Table D. 10

P/A

Origin BEA	1969	1970	1971	1972	1973	1974	1975	1976
55	558633 16.91	374222 11.03	782344 19.42	880904 27.98	888546 29.49	907077 27.04	1560812 38.09	2357006 43.80
115	109249 3.31	86424 2.56	98306 2.44	91498 2.91	93036 3.09	139751 4.17	208480 5.09	313995 5.84
62	99495 3.01	74810 2.22	192954 4.79	228026 7.24	241814 8.03	504382 15.03	893172 21.80	1179524 21.92
47	35050 1.06	44135 1.31	38337 .95	36711 1.17	43354 1.44	41471 1.24	55582 1.36	64795 1.20
54	3696 .11				1300 .04	1421 .04	85[illegible] .21	107242 1.99
66	513 .02	1344 .04				1524 .05	6912 .17	1557 .03
48		2520 .07			12167 .40	6126 .18		7278 .14
50		1348 .04					1512 .04	
52			1234 .03	1200 .04	1543 .05			1461 .03
49				6057 .19	11397 .38	16888 .50	3810 .09	13323 .25
64								1545 .03
TOTAL	3303566 24.42	3374409 17.33	4028548 27.63	3148335 39.53	3013041 42.92	3354575 48.25	4097695 66.85	5381292 75.23

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COMMODITY GROUP 5

Table D. 11

P/A

Destination BEA	1969	1970	1971	1972	1973	1974	1975	1976
47	1568264 47.46	1682650 49.85	1600747 39.74	1107425 35.17	1029058 34.16	957358 28.53	689198 16.82	625047 11.62
48	916721 27.74	1028064 30.46	1082389 26.87	670082 21.28	717254 23.81	672180 20.03	589264 14.38	653382 12.14
55	148973 4.51	153166 4.54	275623 6.84	179175 5.69	127225 4.22	164953 4.92	171293 4.18	156229 2.90
54	38627 1.17	30970 .92	41574 1.03	43607 1.38	13747 .46	20795 .62	9733 .24	21586 .40
62	8619 .26	8143 .24	12915 .32	2744 .09		5433 .16	4550 .11	3003 .06
50	2550 .08	35623 1.06	27530 .68	3341 .11	19089 .63	30888 .92	21316 .52	12691 .24
115	1228 .04	14544 .43	3550 .09	21011 .67	3051 .10	6107 .18	1491 .04	4453 .08
66					1119 .04			1420 .03
52							1406 .03	1466 .03
TOTAL	3304391 81.26	3375426 87.50	4028050 75.57	3148777 64.39	3012464 63.42	3355619 55.36	4097491 36.32	5379062 27.50

COMMODITY GROUP 6

Table D. 12

Origin BEA	1969	1970	1971	1972	1973	1974	1975	1976 P/A
64	2090188 21.08	2107548 19.36	2114217 18.35	2067804 18.13	2070609 19.56	2026953 17.46	1471910 15.72	281451 2.96
52	1929394 19.46	2186355 20.09	2408167 20.90	1574806 13.81	932041 8.81	976821 8.41	775123 8.28	976517 10.27
66	763115 7.70	786255 7.22	772743 6.71	926432 8.12	768419 7.26	1114739 9.60	859078 9.18	945768 9.95
54	264273 2.67	264053 2.43	103355 .90	63032 .55	7411 .07	12713 .11	12173 .13	20918 .22
47	253078 2.55	172809 1.59	222818 1.93	233845 2.05	242629 2.29	218737 1.88	188784 2.02	218365 2.30
115	185268 1.87	182367 1.68	183923 1.60	285805 2.51	339317 3.21	349808 3.01	342058 3.65	345848 3.64
49	41864 .42	42980 .39	45954 .40	39053 .34	37311 .35	29512 .25	23095 .25	24378 .26
48	26024 .26	29412 .27	33517 .29	41256 .36	32380 .31	14614 .13	27775 .30	35868 .38
62	25304 .26	44876 .41	22901 .20	23642 .21	30274 .29	21203 .18	15965 .17	28508 .30
55	4412 .04	24351 .22	27503 .24	2972 .03	26711 .25	131101 1.13	121430 1.30	58097 .61
TOTAL	9915503 56.31	10886095 53.66	11521618 51.52	11405427 46.11	10585755 42.40	11609123 42.16	9363295 41.00	9508480 30.89

COMMODITY GROUP 6

Table D. 13

P/A

Destination BEA	1969	1970	1971	1972	1973	1974	1975	1976
52	4083042	4028282	4269326	4074851	3923001	3956096	3077244	2251092
	41.18	37.01	37.06	35.72	37.07	34.07	32.87	23.68
66	1878946	2049968	1996530	1890889	1552004	1870795	1357139	1490398
	18.95	18.84	17.33	16.58	14.66	16.11	14.50	15.68
62	748751	951638	967616	801186	724911	697467	685321	1006818
	7.55	8.74	8.40	7.02	6.85	6.01	7.32	10.59
49	472630	524069	430064	461728	494062	623649	390684	470294
	4.77	4.82	3.73	4.05	4.67	5.37	4.17	4.95
54	415000	474640	373446	355770	234933	218079	245871	305980
	4.19	4.36	3.24	3.12	2.22	1.88	2.63	3.22
55	271220	841425	1086026	1048397	1077433	1434651	1170354	1137675
	2.74	7.73	9.43	9.19	10.18	12.35	12.50	11.97
47	363035	366840	491633	581661	812185	783573	802654	1051231
	3.66	3.37	4.27	5.10	7.67	6.75	8.57	11.06
64	394887	419093	477589	395933	316558	362520	209845	252007
	3.98	3.85	4.15	3.47	2.99	3.12	2.24	2.65
115	201703	184742	239105	348867	272558	376814	228427	348774
	2.03	1.70	2.08	3.06	2.58	3.24	2.44	3.67
48	113032	110240	161714	290838	259719	249637	225740	229602
	1.14	1.01	1.40	2.55	2.45	2.15	2.41	2.41
TOTAL	9915109	10884306	11520037	11407757	10582684	11611670	9361862	9506301
	90.19	91.43	91.09	89.86	91.34	91.05	89.65	89.88

COMMODITY GROUP 7

Table D. 14

Origin BEA	1969	1970	1971	1972	1973	1974	1975	1976 P/A
52	88651 2.55	43645 1.11	74297 1.67	80674 2.23	67883 2.23	94318 2.53	53395 1.55	68318 2.04
115	11599 .33	35618 .91	41445 .93	57173 1.58	43205 1.42	69278 1.86	73425 2.13	56258 1.68
47	9312 .27	6107 .16	9868 .22	48410 1.34	79137 2.60	7770 .21	9468 .27	38011 1.14
66	5000 .14	9855 .25	5349 .12	17278 .48	43638 1.43	293512 7.87	178163 5.17	186810 5.59
64	2782 .08	7718 .20	52329 1.18	34694 .96	36343 1.19	43156. 1.16	15597 .45	13023 .39
50	1896 .05	6336 .16	29646 .67	33748 .93	7365 .24	1209 .03	2416 .07	672 .02
55		2802 .07		2721 .08				1374 .04
48		1040 .03						
49		1028 .03	2719 .06					1410 .04
54			730 .02	926 .03				
62						650 .02	2608 .08	
TOTAL	3476510 3.42	3931982 2.92	4448922 4.87	3617668 7.63	3044081 9.11	3727984 13.68	3444839 9.72	3348922 10.94

COMMODITY GROUP 7

Table D. 15

Destination BEA	1969	1970	1971	1972	1973	1974	1975	1976 P/A
66	964063	1263666	1543952	1270598	818853	730314	787147	689294
	27.76	32.26	34.79	35.18	26.86	19.58	22.85	20.62
115	675429	576542	615261	557460	537081	717612	458140	592539
	19.45	14.72	13.87	15.43	17.62	19.24	13.30	17.73
52	378092	483466	491662	312522	330749	475783	357180	299123
	10.89	12.34	11.08	8.65	10.85	12.75	10.37	8.95
62	320535	383090	448231	443633	277056	492324	455642	552156
	9.23	9.78	10.10	12.28	9.09	13.20	13.23	16.52
64	302784	365783	521980	320350	341852	485409	616504	308578
	8.72	9.34	11.76	8.87	11.21	13.01	17.90	9.23
47	242262	181261	126351	166282	180874	167013	129779	151662
	6.46	4.63	2.85	4.60	5.93	4.48	3.77	4.54
54	180294	227383	256652	239694	172423	215009	246490	232039
	5.19	5.80	5.78	6.64	5.66	5.76	7.16	6.94
48	137749	156846	116103	62740	80149	38013	49081	81424
	3.97	4.00	2.62	1.74	2.63	1.02	1.43	2.44
55	48625	66682				58212		
	1.40	1.70				1.56		
50	47234	70657	55129	32131	58859	75182	67708	101779
	1.36	1.80	1.24	.89	1.93	2.02	1.97	3.05
49			59786	33232	46585		72543	112042
			1.35	.92	1.53		2.11	3.35
TOTAL	3472849	3917130	4437919	3611706	3048596	3729898	3444845	3342842
	94.43	96.37	95.44	95.20	93.31	92.62	94.09	93.37

COMMODITY GROUP 8

Table D. 16

Origin BEA	1969	1970	1971	1972	1973	1974	1975	1976 P/A
66	2695543 64.68	3429478 65.97	2910713 64.99	3305269 61.24	3187103 58.98	2768807 53.99	2080558 49.96	1713068 39.81
52	362516 8.70	252054 4.85	221264 4.94	235623 4.37	257021 4.76	317394 6.19	293162 7.04	198174 4.61
62	84975 2.04	227333 4.37	87950 1.96	139453 2.58	161353 2.99	103044 2.01	137301 3.30	40426 .94
54	69667 1.67	71189 1.37	40904 .91	56794 1.05	53342 .99	63471 1.24	59369 1.43	57402 1.33
115	54108 1.30	92752 1.78	94507 2.11	103427 1.92	114045 2.11	116367 2.27	102942 2.47	84912 1.97
47	52659 1.26	44966 .87	48481 1.08	52514 .97	50396 .93	31322 .61	44416 1.07	51577 1.20
49	21868 .52	38545 .74	20008 .45	45327 .84	53354 .99	58284 1.14	29255 .70	38510 .89
55	14113 .34	19660 .38	19690 .44	27992 .52	31466 .58	59834 1.17	34393 .83	56632 1.32
64	11801 .28	25294 .49	25001 .56	11010 .20	23171 .43	22029 .43	28337 .68	37336 .87
48							12297 .30	16193 .38
50	6466 .16	1395 .03	17808 .40	10277 .19	10387 .19	9381 .18		
TOTAL	4167506 80.95	5198542 80.85	4478709 77.84	5397239 73.88	5403701 72.95	5128370 69.23	4164448 67.78	4303110 53.32

COMMODITY GROUP 8

Table D. 17

P/A

Destination BEA	1969	1970	1971	1972	1973	1974	1975	1976
66	1832199 43.96	1700730 32.72	1646867 36.77	2065204 38.27	1905844 35.27	1563678 30.49	1243219 29.85	1260639 29.29
62	357990 8.59	333327 6.41	393616 8.79	320296 5.93	364893 6.75	431719 8.42	410084 9.85	519048 12.06
54	176855 4.24	246699 4.75	203989 4.55	313061 5.80	318069 5.89	324174 6.32	260288 6.25	303016 7.04
115	117198 2.81	54278 1.04	70637 1.58	101153 1.87	66217 1.23	82918 1.62	70298 1.69	57108 1.33
55	93300 2.24	96575 1.86	101462 2.27	119763 2.22	151419 2.80	160453 3.13	52095 1.25	79415 1.85
49	83321 2.00	138265 2.66	173987 3.88	233176 4.32	259713 4.81	238097 4.64	181521 4.36	304526 7.08
47	79553 1.91	119252 2.29	153652 3.43	179388 3.32	198050 3.67	215210 4.20	133519 3.21	145124 3.37
52	38232 .92	114377 2.20	77803 1.74	73760 1.37	210944 3.90	131404 2.56	145829 3.50	134353 3.12
48	38688 .93	59382 1.14	60857 1.36	93428 1.73	91753 1.70	114955 2.24	76266 1.83	96060 2.23
64		26727 .51		26027 .48	46434 .86	53674 1.05	22386 .54	78649 1.83
50	11128 .27		22717 .51					
TOTAL	4167878 67.87	5197830 55.58	4478833 64.88	5396404 65.31	5403584 66.88	5128495 64.67	4164888 62.33	4303991 69.20

COMMODITY GROUP 9

Table D. 18

P/A

Origin BEA	1969	1970	1971	1972	1973	1974	1975	1976
115	1958301 23.07	2890863 32.48	3051138 32.73	3154242 35.36	3396605 36.24	5294940 47.77	4655496 43.92	4207252 38.53
66	1090283 12.85	554814 6.23	747155 8.01	459726 5.15	512706 5.47	450505 4.06	446440 4.21	523164 4.79
62	701836 8.27	532379 5.98	291486 3.13	252396 2.83	351615 3.75	238583 2.15	223384 2.11	174065 1.59
54	530774 6.25	516193 5.80	378366 4.06	505339 5.66	426715 4.55	235394 2.12	180182 1.70	120815 1.11
52	510806 6.02	415582 4.67	674933 7.24	392556 4.40	414823 4.43	433964 3.91	406040 3.83	381039 3.49
47	231963 2.73	255864 2.87	288433 3.09	355070 3.98	426319 4.55	447592 4.04	550844 5.20	699188 6.40
55	214543 2.53	310697 3.49	278403 2.99	248781 2.79	263772 2.81	199745 1.80	356872 3.37	934647 8.56
48	176163 2.08	220279 2.47	260916 2.80	260921 2.92	149805 1.60	182240 1.64	265438 2.50	200632 1.84
49	87880 1.04	107398 1.21	109465 1.17	128907 1.44	137271 1.46	139515 1.26	147608 1.39	130911 1.20
50	65784 .78		81347 .87	88586 .99		59083 .53	83011 .78	73803 .68
64		150675 1.69			85464 .91			
TOTAL	8488518 65.62	8900440 66.89	9322145 66.09	8920368 65.52	9372530 65.77	11084236 69.28	10599945 69.01	10919418 68.19

Table D. 19

COMMODITY GROUP 9

P/A

Destination BEA	1969	1970	1971	1972	1973	1974	1975	1976
66	1954488 23.03	1182391 13.28	1447533 15.53	1265050 14.18	1552620 16.56	1463517 13.20	1186619 11.19	1319020 12.08
62	1090374 12.85	1080208 12.14	1154571 12.38	1119962 12.55	1007072 10.74	1095591 9.88	1085431 10.24	866692 7.94
52	644571 7.59	385739 4.33	387389 4.15	253464 2.84	452429 4.83	344990 3.11	410963 3.88	504747 4.62
54	581201 6.85	311913 3.50	439324 4.71	362139 4.06	308130 3.29	229507 2.07	197055 1.86	239095 2.19
48	535447 6.31	634116 7.12	597371 6.41	667293 7.48	168536 6.60	596896 5.38	544233 5.13	684496 6.27
49	367967 4.34	411705 4.63	452690 4.86	360688 4.04	521988 5.57	484732 4.37	443961 4.19	569327 5.21
115	321822 3.79	450645 5.06	816284 8.76	1177260 13.20	377090 4.02	937322 8.46	918670 8.67	742244 6.80
47	243022 2.86	241765 2.72	395375 4.24	326730 3.66	323766 3.45	379320 3.42	391323 3.69	522479 4.79
64	143951 1.70	669197 7.52			286813 3.06			153265 1.40
55	194415 2.29	275979 3.10	342729 3.68	400758 4.49	416191 4.44	718442 6.48	586221 5.53	200551 1.84
50			112545 1.21			158227 1.43	124275 1.17	
TOTAL	8486704 71.61	8903547 63.40	9321011 65.93	8921368 66.50	9375725 62.56	11087250 57.80	10604280 55.55	10919039 53.14

Table D. 20

Origin BEA 66 **Top 5 Destinations, Destination Tonnage and % of Total Originating Tonnage**

	1969	1970	1971	1972	1973	1974	1975	1976
1	66 27508542 88.85	66 27477486 89.05	66 21591733 85.91	66 24368288 85.26	66 25080517 85.57	66 25413760 79.76	66 24415123 74.81	66 26346785 81.76
2	52 2864903 9.25	52 2447140 7.93	52 2073200 8.25	62 2308212 8.08	62 2331522 7.95	62 4220743 13.25	62 4366062 13.38	62 3447179 10.70
3	62 330344 1.07	62 791380 2.56	62 1405498 5.59	52 1845700 6.46	52 1832113 6.25	52 1979903 6.21	49 1933098 5.92	52 1765226 5.48
4	64 125130 .40	115 58199 .19	115 23137 .09	89 15296 .05	64 37580 .13	114 108434 .34	52 1852449 5.68	49 454627 1.41
5	77 21894 .07	64 57799 .19	64 18429 .07	64 13316 .05	115 10895 .04	137 60418 .19	65 28820 .09	65 81936 .25
Total Originating Tonnage	30960310	30854945	25131806	28579605	29310959	31863731	32634377	32222877

Commodity Group 1

O/D

Table D. 21

Origin BEA 55 **Top 5 Destinations, Destination Tonnage and % of Total Originating Tonnage**

	1969	1970	1971	1972	1973	1974	1975	1976
1	54 5953096 24.42	54 5291162 20.62	54 5114494 23.33	54 6361522 24.12	49 6520233 23.42	49 6136320 21.27	49 7314220 24.18	54 6422499 23.08
2	62 3983268 16.34	62 4115883 16.04	138 3384747 15.44	49 4833455 18.32	62 4514724 16.21	54 4451584 15.43	54 6571996 21.73	49 6285675 22.59
3	49 3432652 14.08	138 3485614 13.59	62 3254770 14.85	62 3985659 15.11	54 4343651 15.60	62 4408795 15.28	62 5219969 17.26	62 4944630 17.77
4	138 3001697 12.31	49 3159842 12.32	49 2734047 12.47	138 3708479 14.06	138 2888229 10.37	115 2001537 6.94	138 2887286 9.55	138 2868285 10.31
5	115 2318002 9.51	115 1963503 7.65	55 1566731 7.15	137 2185622 8.29	47 1738145 6.24	137 1844477 6.39	47 1816724 6.01	115 1686100 6.06
Total Originating Tonnage	24374782	25655552	21918438	26376685	27845409	28847045	30246576	27823052

Commodity Group 1

O/D

Table D. 22

Origin BEA 52 **Top 5 Destinations, Destination Tonnage and % of Total Originating Tonnage**

	1969	1970	1971	1972	1973	1974	1975	1976
1	66 6880462 39.67	66 6853606 40.02	52 8457430 39.48	52 7337893 37.95	52 6796329 39.39	52 7289184 45.26	52 8991500 49.77	52 8896710 38.80
2	52 6344072 36.58	52 5906450 34.49	66 7321257 34.18	66 5486932 28.38	66 5350984 31.01	66 4601760 28.57	66 4913699 27.20	66 7897538 34.44
3	62 2751650 15.86	62 3076695 17.97	62 4330761 20.22	62 4704321 24.33	62 3506242 20.32	62 2830677 17.57	62 2438525 13.50	62 4172726 18.20
4	114 339273 1.96	141 356299 2.08	114 359796 1.68	64 631105 3.26	64 442397 2.56	64 530256 3.29	115 408807 2.26	114 449111 1.96
5	77 317206 1.83	114 279633 1.63	64 320081 1.49	114 319603 1.65	141 430381 2.49	114 400704 2.49	64 331695 1.84	137 429800 1.87
Total Originating Tonnage	17344977	17126000	21420455	19335633	17255945	16106348	18067656	22930023

Commodity Group 1 O/D

Table D. 23

Origin BEA 65

Top 5 Destinations, Destination Tonnage and % of Total Originating Tonnage

	1969	1970	1971	1972	1973	1974	1975	1976
1	66 5375617 63.56	66 7299964 71.54	66 5931034 71.55	66 7023286 70.29	66 6140855 69.34	66 6132314 78.35	66 5420727 65.35	66 4575424 74.42
2	65 3082499 36.44	65 2904466 28.46	65 2358784 28.45	65 2968458 29.71	65 2714605 30.65	65 1667477 21.30	65 2874643 34.65	65 1572503 25.58
3					62 880 .01	64 26222 .34		
4						52 958 .01		
5								
Total Originating Tonnage	8458116	10204430	8289818	9991744	8856340	7826971	8295370	6147927

O/D

Commodity Group 1

Table D. 24

Origin BEA 115 **Top 5 Destinations, Destination Tonnage and % of Total Originating Tonnage**

	1969	1970	1971	1972	1973	1974	1975	1976
1	47 1776890 61.63	47 1527988 56.92	47 1567735 35.54	47 1384995 26.08	47 973409 25.36	38 405095 15.46	137 346265 17.53	52 1565762 49.96
2	77 975906 33.85	77 708766 26.40	137 617593 14.00	54 1172522 22.08	39 503401 13.12	49 371711 14.18	39 336574 17.04	46 679827 21.48
3	89 42592 1.48	62 148979 5.55	54 559046 12.67	39 778192 14.65	54 430724 11.22	137 367897 14.04	114 236510 11.97	39 350225 11.06
4	91 34867 1.21	91 98347 3.66	38 431819 9.79	49 395799 7.45	48 422493 11.01	39 345403 13.18	115 216504 10.96	115 221122 6.99
5	49 22114 .77	89 85485 3.18	49 291439 6.61	137 329547 6.20	38 379879 9.90	48 281205 10.73	38 157658 7.98	114 149624 4.73
Total Originating Tonnage	2883082	2684443	4411122	5311501	3838217	2620889	1975091	3165405

Commodity Group 1 O/D

Table D. 25

Destination BEA 66 Top 5 Origins, Originating Tonnage and % of Total Destination Tonnage

	1969	1970	1971	1972	1973	1974	1975	1976
1	66	66	66	66	66	66	66	66
	27508542	27477486	21591733	24368288	25080517	25413760	24415123	26346785
	69.18	66.00	61.92	65.96	68.27	69.86	69.91	67.05
2	52	65	52	65	65	65	65	52
	6880462	7299964	7321257	7023286	6140855	6132314	5420727	7897538
	17.30	17.53	21.00	19.01	16.72	16.86	15.52	20.10
3	65	52	65	52	52	52	52	65
	5375617	6853606	5931034	5486932	5350984	4601760	4913699	4575424
	13.52	16.46	17.01	14.85	14.57	12.65	14.07	11.64
4					54	64	64	54
					92412	71100	52905	185264
					.25	.20	.15	.47
5					114	114	54	62
					51709	67310	50118	135601
					.14	.19	.14	.35
Total Destination Tonnage	39766110	41634831	34870279	36942567	36737386	36375661	34926028	39292824

Commodity Group 1 O/D

Table D. 26

Destination BEA 54 **Top 5 Origins, Originating Tonnage and % of Total Destination Tonnage**

	1969	1970	1971	1972	1973	1974	1975	1976
1	55 5953096 99.33	55 5291162 99.65	55 5114494 88.28	55 6361522 79.10	55 4343651 89.45	55 4451584 94.96	55 6571996 89.63	55 6422499 88.55
2	52 38369 .64	52 17705 .33	115 559046 9.65	115 1172522 14.58	115 430724 8.87	115 160751 3.43	54 402025 5.48	54 827837 11.41
3			114 63689 1.10	114 312778 3.89	114 67980 1.40	49 51275 1.09	114 224495 3.06	
4			52 52111 .90	54 175068 2.18	52 10080 .21	114 19755 .42	52 73005 1.00	
5				52 19986 .25			115 46589 .64	
Total Destination Tonnage	5993309	5309667	5793376	8041876	4856099	4687653	7332567	7253286

Commodity Group 1 O/D

Table D. 27

Destination BEA 52 **Top 5 Origins, Originating Tonnage and % of Total Destination Tonnage**

	1969	1970	1971	1972	1973	1974	1975	1976
1	52	52	52	52	52	52	52	52
	6344072	5906450	8457430	7337893	6796329	7289184	8991500	8896710
	67.43	66.90	78.56	79.15	76.38	69.48	71.08	62.34
2	66	66	66	66	66	66	66	66
	2864903	2447140	2073200	1845700	1832113	1979903	1852449	1765226
	30.45	27.72	19.26	19.91	20.59	18.87	14.65	12.37
3	64	55	55	64	114	114	114	115
	190800	417617	190198	66600	14410	861766	1348631	1565762
	2.03	4.73	1.77	.72	1.62	8.21	10.66	10.97
4		64	64	91	64	64	64	114
		32800	29700	17463	99000	157800	380700	1514025
		.37	.28	.19	1.11	1.50	3.01	10.61
5		91			91	55	55	64
		13721			12879	154279	45000	313200
		.16			.14	1.47	.36	2.19
Total Destination Tonnage	9408472	8828212	10765680	9270882	8898615	10490328	12648942	14220263

Commodity Group 1

O/D

Table D. 28

Destination BEA 62 **Top 5 Origins, Originating Tonnage and % of Total Destination Tonnage**

	1969	1970	1971	1972	1973	1974	1975	1976
1	55 3983268 56.26	55 4115883 50.53	52 4330761 47.69	52 4704321 42.57	55 4514724 42.36	55 4408795 37.00	55 5219969 40.35	55 4944630 36.03
2	52 2751650 38.87	52 3076695 37.77	55 3254770 35.84	55 3985659 36.07	52 3506242 32.90	66 4220743 35.43	66 4366062 33.75	52 4172726 30.41
3	66 330344 4.67	66 791380 9.71	66 1405498 15.48	66 2308212 20.89	66 2331522 21.88	52 2830677 23.76	52 2438525 18.85	66 3447179 25.12
4	54 13645 .19	115 148979 1.83	115 50223 .55	54 51569 .47	62 61354 .58	114 237657 1.99	64 415284 3.21	62 787922 5.74
5		54 12124 .15	54 30616 .34		115 55333 .52	62 189861 1.59	62 226760 1.75	64 212425 1.55
Total Destination Tonnage	7079707	8145968	9081825	11051162	10657350	11914429	12938090	13723565

Commodity Group 1 O/D

Table D. 29

Destination BEA 49 **Top 5 Origins, Originating Tonnage and % of Total Destination Tonnage**

	1969	1970	1971	1972	1973	1974	1975	1976
1	55 3432652 94.94	55 3159842 96.64	55 2734047 90.37	55 4833455 91.44	55 6520233 89.91	55 6136320 93.50	55 7314220 75.92	55 6285675 88.35
2	49 159600 4.41	49 72900 2.23	115 291439 9.63	115 395799 7.49	114 441345 6.09	115 371711 5.66	66 1933098 20.06	66 454627 6.39
3	115 22114 .61	115 36976 1.13		114 46652 .88	115 232070 3.20	49 43272 .66	54 297276 3.09	114 283811 3.99
4	138 1049 .03			77 10042 .19	49 56735 .78	115 8407 .13	49 73509 .76	49 87625 1.23
5					47 1183 .02	140 3130 .05	115 8671 .09	48 1542 .02
Total Destination Tonnage	3615415	3269718	3025486	5285948	7251566	6562840	9634261	7114687

Commodity Group 1

O/D

Table D. 30

Crigin BEA 52 Top 5 Destinations, Destination Tonnage and % of Total Originating Tonnage

	1969	1970	1971	1972	1973	1974	1975	1976
1	66	66	66	66	62	66	66	66
	796397	911778	882416	1235694	1118264	1054156	1209484	1162518
	27.20	28.19	24.27	28.08	27.56	27.21	28.25	26.81
2	62	62	62	62	66	62	62	62
	549982	608593	807051	978043	1056929	925998	970703	943238
	18.78	18.81	22.20	22.22	26.05	23.91	22.67	21.75
3	54	54	54	54	52	52	52	52
	533321	577928	782358	837764	703960	689591	746000	784477
	18.21	17.87	21.52	19.04	17.35	17.80	17.42	18.09
4	52	52	52	52	54	54	54	54
	251203	330114	418216	630023	649198	399873	532846	622818
	8.58	10.21	11.50	14.32	16.00	10.32	12.45	14.36
5	68	68	68	64	64	68	68	68
	242987	286870	226766	274165	285513	306325	269041	313807
	8.30	8.87	6.24	6.23	7.04	7.91	6.28	7.24
Total Originating Tonnage	2928135	3234757	3635155	4400887	4057279	3873568	4281406	4336544

O/D

Commodity Group 2

Table D. 31

Origin BEA 55

Top 5 Destinations, Destination Tonnage and % of Total Originating Tonnage

	1969	1970	1971	1972	1973	1974	1975	1976
1	62	62	54	54	54	54	54	54
	461202	439665	427888	400714	456073	465531	420170	452816
	16.94	16.10	14.38	13.78	17.10	16.78	16.32	16.97
2	54	54	62	62	62	62	62	62
	386134	392889	307910	289943	368656	294196	350420	415780
	14.18	14.39	10.35	9.97	13.82	10.61	13.61	15.58
3	77	49	77	115	46	46	46	46
	256624	242685	286681	261721	298710	262132	310547	335363
	9.43	8.89	9.64	9.00	11.20	9.45	12.07	12.57
4	52	52	49	52	52	52	114	115
	254916	221669	252806	248115	252832	240259	221207	196564
	9.36	8.12	8.50	8.53	9.48	8.66	8.59	7.37
5	49	114	114	77	115	115	52	66
	246713	205245	251905	239015	183875	211279	210581	191585
	9.06	7.52	8.47	8.22	6.89	7.62	8.18	7.18
Total Originating Tonnage	2722781	2730326	2974707	2908053	2667054	2773537	2573791	2668317

O/D

Commodity Group 2

Table D. 32

Origin BEA 62 Top 5 Destinations, Destination Tonnage and % of Total Originating Tonnage

	1969	1970	1971	1972	1973	1974	1975	1976
1	52 308989 26.34	52 357271 31.06	52 393136 31.75	52 458342 33.67	54 492963 30.29	54 588118 33.05	54 457247 28.81	54 689631 41.42
2	54 228212 19.46	54 257055 22.34	54 247115 19.96	54 322656 23.70	52 421346 25.89	52 488405 27.45	52 451195 28.43	52 450587 27.06
3	115 179024 15.26	66 137239 11.93	64 134082 10.83	64 119669 8.79	66 248203 15.25	66 256373 14.41	66 274550 17.30	66 146457 8.80
4	66 123204 10.50	115 120224 10.45	115 131993 10.66	115 101861 7.48	62 160625 9.87	62 143309 8.05	64 124650 7.85	64 123008 7.39
5	64 87126 7.43	64 97192 8.45	49 90038 7.27	62 99081 7.28	115 100975 6.21	64 140833 7.92	115 108526 6.84	115 105037 6.31
Total Originating Tonnage	1172966	1150408	1238203	1361472	1627264	1779278	1586910	1665016

O/D

Commodity Group 2

Table D. 33

Destination BEA 54 **Top 5 Origins, Originating Tonnage and % of Total Destination Tonnage**

	1969	1970	1971	1972	1973	1974	1975	1976
1	138 543038 20.01	52 577928 19.89	52 782358 25.98	52 837764 24.78	138 821132 22.49	138 892840 24.67	138 821534 23.69	138 727732 20.71
2	52 533321 19.65	138 548494 18.88	55 427888 14.21	138 620208 18.35	52 649198 17.78	62 588118 16.25	114 657705 18.97	62 689631 19.63
3	55 386134 14.23	55 392889 13.52	138 400088 13.28	55 400714 11.85	62 492963 13.50	114 581172 16.06	52 532846 15.37	52 622818 17.73
4	137 259422 9.56	62 257055 8.85	137 311938 10.36	62 322656 9.54	114 469219 12.85	55 465531 12.86	62 457247 13.19	114 557716 15.87
5	62 228212 8.41	137 249332 8.58	62 247115 8.20	114 316255 9.36	55 456073 12.49	52 399873 11.05	55 420170 12.12	55 452816 12.89
Total Destination Tonnage	2713449	2905599	3011814	3380593	3650428	3619117	3467663	3513730

Commodity Group 2

O/D

Table D. 34

Destination BEA 66 **Top 5 Origins, Originating Tonnage and % of Total Destination Tonnage**

	1969	1970	1971	1972	1973	1974	1975	1976
1	138 865271 35.24	138 954024 35.36	138 944188 35.06	52 1235694 40.00	138 1287242 35.17	138 1767970 39.12	52 1209484 29.36	52 1162518 31.09
2	52 796397 32.43	52 911778 33.80	52 882416 32.76	138 783227 25.35	52 1056929 28.88	52 1054156 23.33	138 1000108 24.27	138 1011648 27.05
3	141 231577 9.43	141 243949 9.04	141 452213 16.79	141 551583 17.86	141 521507 14.25	141 507841 11.24	141 343333 8.33	141 342572 9.16
4	46 159665 6.50	62 137239 5.09	55 97754 3.63	55 109999 3.56	62 248203 6.78	62 256373 5.67	66 328920 7.98	66 215338 5.76
5	62 123204 5.02	46 133096 4.93	46 90593 3.36	62 98589 3.19	46 186715 5.10	46 194082 4.29	62 274550 6.66	55 191585 5.12
Total Destination Tonnage	2455673	2697854	2693389	3089102	3660070	4519392	4120090	3739360

Commodity Group 2 O/D

Table D. 35

Destination BEA 52 **Top 5 Origins, Originating Tonnage and % of Total Destination Tonnage**

	1969	1970	1971	1972	1973	1974	1975	1976
1	138	138	138	52	52	52	52	52
	440293	475088	448274	630023	703960	689591	746000	784477
	27.78	27.27	24.26	28.21	31.89	27.74	31.37	32.20
2	62	62	52	138	138	138	138	138
	308989	357271	418216	471279	458954	509992	496855	550284
	19.50	20.51	22.63	21.10	20.79	20.51	20.89	22.59
3	55	52	62	62	62	62	62	62
	254916	330114	393136	458342	421346	488405	451195	450587
	16.09	18.95	21.27	20.52	19.09	19.65	18.97	18.50
4	52	55	55	55	55	55	55	54
	251203	221669	248342	248115	252832	240259	210581	124463
	15.85	12.72	13.44	11.11	11.45	9.66	8.85	5.11
5	66	140	140	140	140	66	66	141
	88539	101096	108740	123220	128443	128979	156154	123477
	5.59	5.80	5.88	5.52	5.82	5.19	6.57	5.07
Total Destination Tonnage	1584741	1742223	1847943	2233444	2207485	2485959	2378181	2435905

O/D

Commodity Group 2

Table D. 36

Destination BEA 62 **Top 5 Origins, Originating Tonnage and % of Total Destination Tonnage**

	1969	1970	1971	1972	1973	1974	1975	1976
1	<u>52</u>	<u>52</u>	<u>52</u>	<u>52</u>	<u>52</u>	<u>52</u>	<u>52</u>	<u>52</u>
	549982	608593	807051	978043	1118264	925998	970703	943238
	31.91	36.90	45.75	48.40	51.52	48.67	49.37	50.46
2	<u>55</u>	<u>55</u>	<u>55</u>	<u>55</u>	<u>55</u>	<u>55</u>	<u>55</u>	<u>55</u>
	461202	439665	307910	289943	368656	294196	350420	415780
	26.76	26.66	17.45	14.35	16.99	15.46	17.82	22.24
3	<u>138</u>	<u>138</u>	<u>138</u>	<u>138</u>	<u>114</u>	<u>138</u>	<u>138</u>	<u>138</u>
	232868	160819	179808	250548	180811	213051	182651	180558
	13.51	9.75	10.19	12.40	8.33	11.20	9.29	9.66
4	<u>46</u>	<u>46</u>	<u>114</u>	<u>114</u>	<u>138</u>	<u>114</u>	<u>114</u>	<u>114</u>
	132399	138630	127479	248921	165475	191673	165186	76587
	7.68	8.41	7.23	12.32	7.62	10.07	8.40	4.10
5	<u>137</u>	<u>137</u>	<u>46</u>	<u>137</u>	<u>62</u>	<u>62</u>	<u>62</u>	<u>139</u>
	117186	115210	95453	67170	160625	143309	98212	46758
	6.80	6.99	5.41	3.32	7.40	7.53	4.99	2.50
Total Destination Tonnage	1723567	1649153	1764068	2020704	2170366	1902788	1966285	1869422

O/D

Commodity Group 2

Table D. 37

Origin BEA 54

Top 5 Destinations, Destination Tonnage and % of Total Originating Tonnage

	1969	1970	1971	1972	1973	1974	1975	1976
1	54	54	54	54	54	54	54	54
	3515673	2142429	2432841	1721786	2779899	2714370	2707263	2659914
	61.73	51.25	52.39	45.24	56.59	61.73	56.21	48.99
2	55	55	55	55	55	62	55	55
	1271662	1271241	983750	1015600	854842	641738	809800	971500
	22.33	30.41	21.19	23.91	17.40	14.60	16.81	17.89
3	62	62	62	62	62	52	62	62
	698556	552585	809004	862262	804626	517630	520940	970186
	12.27	13.22	17.42	20.30	16.38	11.77	10.82	17.87
4	52	52	52	52	52	55	52	52
	133561	209686	403942	446610	450329	492050	400640	616216
	2.35	5.02	8.70	10.51	9.17	11.19	8.32	11.35
5	64	66	66	66	64	66	49	49
	75608	2730	12682	1282	12237	12963	321300	138975
	1.33	.07	.27	.03	.25	.29	6.67	2.56
Total Originating Tonnage	5695060	4180366	4643497	4247540	4911925	4396922	4816639	5429281

O/D

Commodity Group 4

Table D. 38

Origin BEA 66

Top 5 Destinations, Destination Tonnage and % of Total Originating Tonnage

	1969	1970	1971	1972	1973	1974	1975	1976
1	66 4982461 90.08	66 4644807 99.06	66 5082181 99.61	66 2982984 98.82	66 4438380 99.85	66 4429774 99.19	66 3775059 99.84	66 3762953 81.78
2	64 508940 9.20	65 25925 .55	64 8900 .17	64 17764 .59	65 3465 .08	64 27038 .61	64 4377 .12	64 719286 15.63
3	52 28830 .52	64 18200 .39	52 4507 .09	65 16011 .53	64 1840 .04	52 7753 .17	52 1562 .04	52 116354 2.53
4	65 9646 .17		62 3952 .08	52 1876 .06	52 1311 .03	141 1407 .03		65 2847 .06
5	139 1501 .03							
Total Originating Tonnage	5531378	4688932	5102301	3018635	4444996	4465972	3780998	4601440

O/D

Commodity Group 4

Table D. 39

Origin BEA 115

Top 5 Destinations, Destination Tonnage and % of Total Originating Tonnage

	1969	1970	1971	1972	1973	1974	1975	1976
1	115	115	115	115	115	115	115	115
	1359605	1671152	1431904	1287858	1565422	1437964	1129875	1397876
	48.49	48.29	39.56	35.12	40.43	31.03	32.46	36.99
2	49	49	49	49	49	49	49	49
	782600	789400	885482	1172750	1396633	1366314	1011284	1128927
	27.91	22.81	24.46	31.98	36.07	29.49	29.06	29.87
3	138	46	46	46	46	46	46	46
	214387	465459	728062	931980	681782	1264398	967152	584456
	7.65	13.45	20.11	25.42	17.61	27.29	27.79	15.46
4	46	138	138	138	138	138	138	138
	183765	281332	274401	113156	92174	158802	133335	419933
	6.55	8.13	7.58	3.09	2.38	3.43	3.83	11.11
5	47	55	135	141	114	133	114	114
	116352	98557	150971	73774	47850	126591	72020	99873
	4.15	2.85	4.17	2.01	1.24	2.73	2.07	2.64
Total Originating Tonnage	2803794	3460758	3619904	3666744	3871830	4633641	3480490	3779448

O/D

Commodity Group 4

Table D. 40

Origin BEA 62 **Top 5 Destinations, Destination Tonnage and % of Total Originating Tonnage**

	1969	1970	1971	1972	1973	1974	1975	1976
1	62 982757 49.26	52 828520 46.79	52 1137317 46.93	52 1245620 51.66	52 1093473 65.08	52 879110 50.99	52 736257 58.11	52 922458 68.17
2	52 683605 34.27	62 779661 44.03	62 883152 36.45	62 901786 37.40	62 346759 20.64	62 633392 36.74	62 298831 23.58	66 219735 16.24
3	64 160817 8.06	66 114247 6.45	66 214617 8.86	66 237689 9.86	66 220180 13.10	66 210010 12.18	66 169535 13.38	62 154837 11.44
4	66 159925 8.02	64 47174 2.66	54 141042 5.82	54 16525 .69	64 19861 1.18	55 1552 .09	64 45889 3.62	54 44812 3.31
5	54 6993 .35	54 1000 .06	64 45259 1.87	68 7006 .29			54 14912 1.18	64 9836 .73
Total Originating Tonnage	1994902	1770602	2423187	2411272	1680273	1724064	1267055	1353214

Commodity Group 4

O/D

Table D. 41

Origin BEA 52

Top 5 Destinations, Destination Tonnage and % of Total Originating Tonnage

	1969	1970	1971	1972	1973	1974	1975	1976
1	52 1314639 99.51	52 1201947 99.58	52 1270013 99.11	52 1436435 99.47	52 1364213 99.63	52 1549123 98.23	52 1414268 89.19	52 1710686 96.83
2	62 5841 .44	66 2888 .24	66 8163 .64	62 4000 .28	47 4159 .30	64 19246 1.22	54 94370 5.95	64 46640 2.64
3	55 669 .05	64 2137 .18	62 3197 .25	66 3684 .26	62 950 .07	62 8692 .55	115 29533 1.86	66 7652 .43
4							64 25653 1.62	54 1632 .09
5							66 21869 1.38	
Total Originating Tonnage	1321149	1206972	1281373	1444119	1369322	1577061	1585693	1766610

Commodity Group 4

O/D

Table D. 42

Origin BEA 48

Top 5 Destinations, Destination Tonnage and % of Total Originating Tonnage

	1969	1970	1971	1972	1973	1974	1975	1976
1	48 1254004 100.00	48 1186581 100.00	48 1406988 100.00	48 1403160 100.00	48 1652598 99.83	48 1762626 100.00	48 1288204 99.69	48 1135483 94.08
2					50 2839 .17		47 4000 .31	47 61200 5.07
3								50 10282 .85
4								
5								
Total Originating Tonnage	1254004	1186581	1406988	1403160	1655437	1762626	1292204	1206965

Commodity Group 4

O/D

Table D. 43

Origin BEA 64 **Top 5 Destinations, Destination Tonnage and % of Total Originating Tonnage**

	1969	1970	1971	1972	1973	1974	1975	1976
1	64 388837 55.58	64 947215 67.34	64 1087734 56.64	66 775552 46.15	64 779686 46.87	64 790058 54.60	64 1098453 62.06	64 420906 57.67
2	66 300895 43.01	66 394050 28.02	66 772346 40.22	64 692760 41.23	66 763291 45.88	66 554722 38.33	66 621202 35.10	66 253182 34.69
3	52 8665 1.24	52 65284 4.64	52 60199 3.13	52 212060 12.62	52 120567 7.25	52 98779 6.83	52 50367 2.85	52 55809 7.65
4	65 1257 0.18					65 3510 .24		
5								
Total Originating Tonnage	699654	1406549	1920279	1680572	1663544	1447069	1770022	729897

Commodity Group 4 O/D

Table D. 44

Destination BEA 66 **Top 5 Origins, Originating Tonnage and % of Total Destination Tonnage**

	1969	1970	1971	1972	1973	1974	1975	1976
1	66	66	66	66	66	66	66	66
	4982461	4644807	5082181	2982984	4438380	4429774	3775059	3762953
	82.93	81.65	78.03	52.78	74.46	77.74	73.06	77.84
2	65	64	64	68	64	64	64	65
	545023	394050	772346	1189080	763291	554722	621202	586334
	9.07	6.93	11.86	21.04	12.81	9.73	12.02	12.13
3	64	65	65	64	65	65	65	64
	300895	384179	421415	775552	518500	447100	523875	253182
	5.01	6.75	6.47	13.72	8.70	7.85	10.14	5.24
4	62	62	62	65	62	62	62	62
	159925	114247	214617	461550	220180	210010	169535	219735
	2.66	2.01	3.30	8.17	3.69	3.69	3.28	4.55
5	115	134	54	62	114	115	55	52
	10793	104975	12682	237689	11141	26628	26239	7652
	.18	1.85	.19	4.21	.19	.47	.51	.16
Total Destination Tonnage	6007910	5688602	6512788	5651821	5960807	5698544	5166886	4834056

O/D

Commodity Group 4

Table D. 45

Destination BEA 52 **Top 5 Origins, Originating Tonnage and % of Total Destination Tonnage**

	1969	1970	1971	1972	1973	1974	1975	1976
1	52	52	52	52	52	52	52	52
	1314639	1201947	1270013	1436435	1364213	1549123	1414268	1710686
	60.39	51.73	43.91	42.96	44.28	50.34	53.22	48.70
2	62	62	62	62	62	62	62	62
	683605	828520	1137317	1245620	1093473	879110	736257	922458
	31.40	35.66	39.32	37.25	35.49	28.56	27.70	26.26
3	54	54	54	54	54	54	54	54
	133561	209686	403942	446610	450329	517630	400640	616216
	6.14	9.02	13.97	13.36	14.62	16.82	15.08	17.54
4	64	64	64	64	64	64	55	66
	8665	65284	60199	212060	120567	98779	51757	116354
	.40	2.81	2.08	6.34	3.91	3.21	1.95	3.31
5	115	115	115	66	55	55	64	55
	5377	18005	9916	1876	49493	25196	50367	91359
	.25	.77	.34	.06	1.61	.82	1.90	2.60
Total Destination Tonnage	2176917	2323442	2892112	3343916	3080771	3077591	2657522	3512882

Commodity Group 4

O/D

Table D. 46

Destination BEA 54 **Top 5 Origins, Originating Tonnage and % of Total Destination Tonnage**

	1969	1970	1971	1972	1973	1974	1975	1976
1	54	54	54	54	54	54	54	54
	3515673	2142429	2432841	1921786	2779899	2714370	2707263	2659914
	95.07	99.86	94.32	92.74	99.66	99.75	94.51	97.07
2	49	55	62	55	55	115	52	62
	73000	2000	141042	133940	4759	3807	94370	44812
	1.97	.09	5.47	6.46	.17	.14	3.29	1.64
3	55	62	137	62	137	138	55	55
	52000	1000	2919	16525	2828	1560	42452	32626
	1.41	.05	.11	.80	.10	.06	1.48	1.19
4	115		55		138	55	62	52
	34328		2650		1898	1500	14912	1632
	.93		.10		.07	.06	.52	.06
5	47						115	
	16147						3880	
	.44						.14	
Total Destination Tonnage	3698141	2145429	2579452	2072251	2789384	2721237	2864474	2740157

Commodity Group 4 O/D

Table D. 47

Destination BEA 55

Top 5 Origins, Originating Tonnage and % of Total Destination Tonnage

	1969	1970	1971	1972	1973	1974	1975	1976
1	54 1271662 53.49	54 1271241 50.06	55 1389700 57.70	54 1015600 52.26	55 1457044 63.02	55 1214996 70.73	54 809800 64.80	54 971500 72.14
2	55 1047050 44.04	55 1169650 46.06	54 983750 40.84	55 919650 47.32	54 854842 36.98	54 492050 28.65	55 429350 34.46	55 372250 27.64
3	115 57113 2.40	115 98557 3.88	115 34300 1.42	115 8272 .43		115 9127 .53	115 7562 .61	62 1536 .11
4	62 805 .03		77 756 .03			62 1552 .09	62 1631 .13	117 1365 .10
5	52 669 .03						46 1316 .11	
Total Destination Tonnage	2377299	2539448	2408506	1943522	2311886	1717725	1249659	1346651

O/D

Commodity Group 4

Table D. 48

Destination BEA 49 **Top 5 Origins, Originating Tonnage and % of Total Destination Tonnage**

	1969	1970	1971	1972	1973	1974	1975	1976
1	115 782600 63.52	115 789400 51.01	115 885482 50.72	115 1172750 77.48	115 1396633 60.33	115 1366314 62.75	115 1011284 56.71	115 1128927 62.09
2	49 435150 35.32	49 730550 47.21	49 706805 40.48	49 297373 19.65	46 537045 23.20	46 409600 18.81	49 358235 20.09	49 421390 23.18
3	46 14000 1.14	46 27525 1.78	46 153655 8.80	46 43545 2.88	49 381322 16.47	49 366480 16.83	54 321300 18.02	54 138975 7.64
4	138 300 .02					47 34850 1.60	46 76280 4.28	46 99850 5.49
5							47 16300 .91	47 29100 1.60
Total Destination Tonnage	1232050	1547475	1745942	1513668	2315000	2177244	1783399	1818242

O/D

Commodity Group 4

APPENDIX E: Commodity Group Definitions

Table E. 1: COMMODITY GROUPINGS TO BE UTILIZED FOR PROJECTING OHIO RIVER BASIN WATERWAY TRAFFIC

	COMMODITY GROUP	W.C.S.C.* Commodity Codes
1.	Coal and Coke	1121, 2920, 3313
2.	Petroleum Fuels	2911 thru 2915, 2921
3.	Crude Petroleum	1311
4.	Aggregates	0931, 1411 thru 1442
5.	Grains	0102 thru 0111
6.	Chemical and Chemical Fertilizers	2810 thru 2891
7.	Ores and Minerals	1021 thru 1091, 1451, 1491 thru 1499
8.	Iron Ore and Iron and Steel	1011, 3311, 3314 thru 3319, 4011
9.	All Other	0101, 0112 thru 0913, 1471, 1479 1911 thru 2711, 2916, 2917, 2918, 2951 thru 3291, 3312, 3321 thru 3911, 4012 thru 4113, 4118, 9999

*Waterborne Commerce Statistical Center

Table E. 2: COMMODITY CLASSIFICATION FOR SHIPPING STATISTICS

Note: The commodity descriptions used in the statistical tables in this publication are abbreviated forms—to conserve printing space—of the following commodities.

Code No.	Item Name
	Group 01—Farm Products
0101	Cotton, raw
0102	Barley and rye
0103	Corn
0104	Oats
0105	Rice
0106	Sorghum grains
0107	Wheat
0111	Soybeans
0112	Flaxseed
0119	Oilseeds, not elsewhere classified
0121	Tobacco, leaf
0122	Hay and fodder
0129	Field crops, not elsewhere classified
0131	Fresh fruits and tree nuts, except bananas and plantains
0132	Bananas and plantains
0133	Coffee, green and roasted (including instant)
0134	Cocoa beans
0141	Fresh and frozen vegetables
0151	Live animals (livestock), except zoo animals, cats, dogs, etc.
0161	Animals and animal products, not elsewhere classified
0191	Miscellaneous farm products
	Group 08—Forest Products
0841	Crude rubber and allied gums
0861	Forest products, not elsewhere classified
	Group 09—Fresh Fish and Other Marine Products
0911	Fresh fish, except shellfish
0912	Shellfish, except prepared or preserved
0913	Menhaden
0931	Marine shells, unmanufactured
	Group 10—Metallic Ores
1011	Iron ore and concentrates
1021	Copper ore and concentrates
1051	Bauxite and other aluminum ores and concentrates
1061	Manganese ores and concentrates
1091	Nonferrous metal ores and concentrates, not elsewhere classified
	Group 11—Coal
1121	Coal and lignite
	Group 13—Crude Petroleum
1311	Crude petroleum
	Group 14—Nonmetallic Minerals, Except Fuels
1411	Limestone flux and calcareous stone
1412	Building stone, unworked
1442	Sand, gravel and crushed rock
1451	Clay, ceramic and refractory materials
1471	Phosphate rock
1479	Natural fertilizer materials, not elsewhere classified
1491	*Salt
1492	Sulphur, dry
1493	Sulphur, liquid
1494	Gypsum, crude and plasters
1499	Nonmetallic minerals, except fuels, not elsewhere classified
	Group 19—Ordnance and Accessories
1911	Ordnance and accessories
	Group 20—Food and Kindred Products
2011	Meat, fresh, chilled, or frozen
2012	Meat and meat products prepared or preserved, including canned meat products
2014	Tallow, animal fats and oils
2015	Animal by-products, not elsewhere classified
2021	Dairy products, except dried milk and cream
2022	Dried milk and cream
2031	Fish and fish products, including shellfish, prepared or preserved
2034	Vegetables and preparations, canned and otherwise prepared and preserved
2039	Fruits and fruit and vegetable juices, canned and otherwise prepared or preserved
2041	Wheat flour and semolina
2042	Prepared animal feeds
2049	Grain mill products, not elsewhere classified
2061	Sugar
2062	Molasses
2081	Alcoholic beverages
2091	Vegetable oils, all grades; margarine and shortening
2092	Animal oils and fats, not elsewhere classified, including marine
2094	Groceries
2095	Ice
2099	Miscellaneous food products
	Group 21—Tobacco Products
2111	Tobacco manufactures
	Group 22—Basic Textiles
2211	Basic textile products, except textile fibers
2212	Textile fibers, not elsewhere classified
	Group 23—Apparel and Other Finished Textile Products, Including Knit
2311	Apparel and other finished textile products, including knit
	Group 24—Lumber and Wood Products Except Furniture
2411	Logs
2412	Rafted logs
2413	Fuel wood, charcoal, and wastes
2414	Timber, posts, poles, piling, and other wood in the rough
2415	Pulpwood, log
2416	Wood chips, staves, moldings, and excelsior
2421	Lumber
2431	Veneer, plywood, and other worked wood
2491	Wood manufactures, not elsewhere classified
	Group 25—Furniture and Fixtures
2511	Furniture and fixtures
	Group 26—Pulp, Paper and Allied Products
2611	Pulp
2621	Standard newsprint paper
2631	Paper and paperboard
2691	Pulp, paper and paperboard products, not elsewhere classified
	Group 27—Printed Matter
2711	Printed matter

* See footnote at end of Commodity Classification.

Table E. 2: Commodity Classification for Shipping Statistics (continued)

Group 28—Chemicals and Allied Products

- 2810 Sodium hydroxide (caustic soda)
- 2811 Crude products from coal tar, petroleum, and natural gas, except benzene and toluene
- 2812 Dyes, organic pigment, dyeing and tanning materials
- 2813 Alcohols
- 2816 Radioactive and associated materials, including wastes
- 2817 Benzene and toluene, crude and commercially pure
- 2818 Sulphuric acid
- 2819 Basic chemicals and basic chemical products, not elsewhere classified
- 2821 Plastic materials, regenerated cellulose and synthetic resins, including film, sheeting, and laminates
- 2822 Synthetic rubber
- 2823 Synthetic (man-made) fiber
- 2831 Drugs (biological products, medicinal chemicals, botanical products and pharmaceutical preparations)
- 2841 Soap, detergents, and cleaning preparations; perfumes, cosmetics and other toilet preparations
- 2851 Paints, varnishes, lacquers, enamels, and allied products
- 2861 Gum and wood chemicals
- 2871 Nitrogenous chemical fertilizers, except mixtures
- 2872 Potassic chemical fertilizers, except mixtures
- 2873 Phosphatic chemical fertilizers, except mixtures
- 2876 Insecticides, fungicides, pesticides, and disinfectants
- 2879 Fertilizers and fertilizer materials, not elsewhere classified
- 2891 Miscellaneous chemical products

Group 29—Petroleum and Coal Products

- 2911 Gasoline, including natural gasoline
- 2912 Jet fuel
- 2913 Kerosene
- 2914 Distillate fuel oil
- 2915 Residual fuel oil
- 2916 Lubricating oils and greases
- 2917 Naphtha, mineral spirits, solvents, not elsewhere classified
- 2918 Asphalt, tar, and pitches
- 2920 Coke, including petroleum coke
- 2921 Liquefied petroleum gases, coal gases, natural gas, and natural gas liquids
- 2951 Asphalt building materials
- 2991 Petroleum and coal products, not elsewhere classified

Group 30—Rubber and Miscellaneous Plastics Products

- 3011 Rubber and miscellaneous plastics products

Group 31—Leather and Leather Products

- 3111 Leather and leather products

Group 32—Stone, Clay, Glass, and Concrete Products

- 3211 Glass and glass products
- 3241 Building cement
- 3251 Structural clay products, including refractories
- 3271 Lime
- 3281 Cut stone and stone products
- 3291 Miscellaneous nonmetallic mineral products

Group 33—Primary Metal Products

- 3311 Pig iron
- 3312 Slag
- 3313 Coke (coal and petroleum), petroleum pitches and asphalts, and naphtha and solvents
- 3314 Iron and steel ingots, and other primary forms, including blanks for tube and pipe, and sponge iron
- 3315 Iron and steel bars, rods, angles, shapes and sections, including sheet piling
- 3316 Iron and steel plates and sheets
- 3317 Iron and steel pipe and tube
- 3318 Ferroalloys
- 3319 Primary iron and steel products, not elsewhere classified, including castings in the rough

Group 33—Continued

- 3321 Nonferrous metals primary smelter products, basic shapes, wire, castings and forgings, except copper, lead, zinc and aluminum
- 3322 Copper and copper alloys, whether or not refined, unworked
- 3323 Lead and zinc including alloys, unworked
- 3324 Aluminum and aluminum alloys, unworked

Group 34—Fabricated Metal Products, Except Ordnance, Machinery, and Transportation Equipment

- 3411 Fabricated metal products, except ordnance, machinery, and transportation equipment

Group 35—Machinery, Except Electrical

- 3511 Machinery, except electrical

Group 36—Electrical Machinery, Equipment and Supplies

- 3611 Electrical machinery, equipment and supplies

Group 37—Transportation Equipment

- 3711 Motor vehicles, parts and equipment
- 3721 Aircraft and parts
- 3731 Ships and boats
- 3791 Miscellaneous transportation equipment

Group 38—Instruments, Photographic and Optical Goods, Watches and Clocks

- 3811 Instruments, photographic and optical goods, watches and clocks

Group 39—Miscellaneous Products of Manufacturing

- 3911 Miscellaneous products of manufacturing

Group 40—Waste and Scrap Materials

- 4011 Iron and steel scrap
- 4012 Nonferrous metal scrap
- 4022 Textile waste, scrap, and sweepings
- 4024 Paper waste and scrap
- 4029 Waste and scrap, not elsewhere classified

Group 41—Special Items

- 4111 Water
- 4112 Miscellaneous shipments not identifiable by commodity
- 4113 LCL freight
- 4116 Materials used in waterway improvement, Government materials
- 9999** Department of Defense controlled cargo and special category items

Statistics on salt in this publication are included with "Nonmetallic minerals, except fuels, not elsewhere classified," commodity code 1499, to avoid disclosure of individual company operations.

** Cargoes exported on Department of Defense controlled vessels (other than goods for the use of U. S. Armed Forces abroad) and non-Department of Defense shipments of military component items (abbreviated SCI) for which commodity detail is not furnished to the Corps of Engineers.